

**STUDY TITLE:**  
WORKER REENTRY EXPOSURES AND REENTRY INTERVALS  
ASSOCIATED WITH THE USE OF ENDOSULFAN EC AND WP FORMULATIONS

**DATA REQUIREMENT:**  
Not Applicable

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**STUDY COMPLETED ON:**  
September 7, 2000

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ENDO: 00-RS05

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**PURPOSE of SUBMISSION:**  
Response to HED's Postapplication Exposure Assessments  
For the Endosulfan RED Document

**SUBMISSION VOLUME:**  
Volume 1 of 2

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## **STATEMENT OF NO CONFIDENTIALITY CLAIMS**

No claim of confidentiality is made for any information contained in this document on the basis of its falling within the scope of FIFRA 10(d)(1)(A), (B), or (C).

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Date: 9/14/00

## GOOD LABORATORY PRACTICE COMPLIANCE STATEMENT

The following exposure/risk assessment is not subject to the principles of 40 CFR 160, GOOD LABORATORY PRACTICE STANDARDS (FIFRA), as promulgated in Federal Register, 54, No. 158, 34067-34704, 17 August 1989. Key dislodgeable foliar residue (DFR) and worker exposure studies represented by the data summarized in this report may have been conducted in accordance with the appropriate GLP standards as verified by the GLP compliance statements found in the corresponding original study reports.

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## QUALITY ASSURANCE STATEMENT

REPORT TITLE:     WORKER REENTRY EXPOSURES AND REENTRY INTERVALS  
                         ASSOCIATED WITH THE USE OF ENDOSULFAN EC AND WP  
                         FORMULATIONS

### REPORT

IDENTIFICATION: ENDO: 00-RS05

The report was audited and reviewed with respect to the study data, data files, algorithms and data transformations used in the exposure/risk analysis. Dislodgeable foliar residue (DFR) and exposure data were derived from the individual supporting studies. Transfer coefficients were derived from studies conducted by the Agricultural Reentry Task Force (ARTF). The Microsoft Excel<sup>®</sup> spreadsheets and the results of the formulae used to calculate exposures and risks (margins of exposure) were independently verified. The information in the report is representative of the spreadsheets, formulae, and data tables, and the report contents accurately reflect the data.

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# **WORKER REENTRY EXPOSURES AND REENTRY INTERVALS ASSOCIATED WITH THE USE OF ENDOSULFAN EC AND WP FORMULATIONS**

## **I. SUMMARY**

This report presents the results of a screening-level worker reentry exposure assessment for Endosulfan (CAS No. 115-29-7), which is the active ingredient (a.i.) in the emulsifiable concentrate (EC) and wettable powder (WP) formulations being supported by the Endosulfan Task Force (ETF). The specific product labels are for Phaser<sup>®</sup> 3EC [USEPA Reg. No. 264-638], which is an emulsifiable concentrate formulation containing 3.0 lbs of endosulfan per gallon of formulation, and Phaser<sup>®</sup> 50WSB [USEPA Reg. No. 264-656], which contains 50 percent active ingredient in wettable powder form in water soluble bags. These formulations are proposed for use to control insects in a variety of agricultural crops (including, for example, melons, peaches, apples, grapes, sweet corn, lettuce, potatoes, carrots, cauliflower, cotton, beans, strawberries, tobacco, tomatoes), commercially-grown trees and shrubs, and commercially-grown greenhouse tomatoes.

This assessment is based on dislodgeable foliar residue (DFR) data on endosulfan from studies conducted on behalf of the Endosulfan Task Force (ETF) on melons, peaches, and grapes [MRID No.444031-02]. Even though the Agency used the data from this study to develop the occupational exposure assessment for the HED assessment (USEPA 2000a), the assessment presented here differs from the HED assessment in a number of important ways, including (1) the use of more recently developed transfer coefficients from the Agricultural Reentry Task Force (ARTF) efforts; (2) the recognition of the bi-phasic nature of the dissipation curves for endosulfan residues on treated foliage, and the resulting appropriate adjustments to the dissipation rate functions; (3) the use of the more appropriate NOEL of 9 mg/kg/day rather than the NOEL of 3 mg/kg/day used by the Agency; (4) use of crop-specific use rates; and (5) full use of the available formulation-specific dissipation data for the EC and WP formulations. The specific position of the Endosulfan Task Force with respect to toxicology issues has been provided as part of a separate 30-day response to the Agency's proposed risk assessment for the Reregistration Eligibility Decision (RED) document on endosulfan (Aventis 2000; MRID No. 45122-01). The effects observed in the study selected by the Agency do not appear to be treatment-related and the liver effects appear to be of very slight severity. If all four available subchronic dermal studies for endosulfan are evaluated as a group, it is the contention of the Task Force that the weight-of-evidence supports a NOAEL of 9 mg/kg/day for the evaluation of short-term, intermediate-term, and long-term dermal exposures.

The TCs used in the endosulfan RED were referenced to an EPA policy memo (USEPA, 1998) that does not appear to be applied uniformly from one pesticide to the next, and the TCs recommended by the Agency are not consistent with those based on recent studies conducted under GLP by the ARTF and most of those in the published literature. On average, the TC values used in the HED document (USEPA 2000a) are roughly 2 to 4 times higher than those

supported by the ARTF data. For instance, the TC for melon harvesters used by the Agency appears to be 2-fold higher than those from reentry exposure studies developed by ARTF. EPA used a default of 10,000 cm<sup>2</sup>/hr for fruit tree harvesters, while ARTF has developed 8 studies with TCs ranging from 885 to 6891 cm<sup>2</sup>/hr.

A dissipation study for foliar dislodgeable residues of endosulfan associated with use of Phaser<sup>®</sup> 3EC and Phaser<sup>®</sup> 50WSB on melons, peaches, and grapes has been submitted to the Agency (MRID No. 444031-02). This study was conducted near Fresno, California in 1995. When the DFR data are forced to fit a single log-linear regression across the entire time frame of the DFR data, mediocre correlation coefficients occur (e.g., 0.71 for peaches, 0.52 for grapes, and 0.76 for melons for the EC formulation). If the DFR data are plotted in a log-linear fashion (i.e., ln [DFR] vs. time), the biphasic nature of the dissipation curve is readily apparent. For endosulfan, there appears to be an initial rapid decline phase (“Phase 1”) followed by a much slower decline phase (“Phase 2”). Thus, if the data for the EC or WP formulation from the study report are plotted in a log-linear form, the DFR data suggest a “hockey stick” type of plot rather than a single straight line plot. The half-lives estimated for the 2 formulation types for melons, peaches, and grapes based on biphasic kinetics are shown in Table 1. Across the three crop types studied (melons, peaches, and grapes), the Phase 1 half-life is more than one order of magnitude shorter than the Phase 2 half-life for a given crop/formulation type combination. The Phase 1 and Phase 2 half-lives for the WP formulation are about two to ten or more times longer than the respective half-lives for the EC formulation (except for peaches). Thus, the WP formulation half-lives should not be used to represent the respective half-lives for the EC formulation or overestimation of exposures will occur.

**Table 1. Half-Life Estimates Based on Biphasic (2-Compartment) Kinetics (Agrevo 1997)**

Formulation Type	Crop	Foliar Dissipation Half-Life (Days)	
		Rapid-Phase (Phase 1)	Slow-Phase (Phase 2)
EC	Melons	0.7	8.6
	Peaches	0.4	10.5
	Grapes	0.7	11.1
WP	Melons	2.9	2,240
	Peaches	0.3	6.2
	Grapes	2.5	84.8

Short-term and intermediate-term daily exposures were calculated to allow comparison to the daily exposures estimated by the Agency. The worker exposure scenarios addressed in this assessment include harvesting and irrigating grapes; scouting and harvesting of low-growing fruit and vegetable crops with low potential for dermal transfer of residues to workers, harvesting of field crops with medium potential for dermal transfer of residues to workers;

scouting/irrigation and harvesting of field crops with high potential for dermal transfer of residues to workers; harvesting of fruit trees; and irrigation and packing of ornamentals. Daily DFR levels predicted by the relevant regression equations based on biphasic kinetics were used in calculating exposures. Because the DFR studies were conducted at the maximum label rates for the EC and WP formulations, no adjustment of the DFR estimates was necessary in estimating exposures. Margins of Exposure (MOEs) were calculated using the estimated exposures and the appropriate NOEL of 9 mg/kg/day.

Worker reentry intervals (REIs) were directly calculated using methods consistent with the USEPA Subdivision K guidelines (USEPA 1984; 1997), Pependorf (1985) and Ross and Dong (1996). The REIs that were directly derived were consistent with the separate daily exposure estimates based on predicted DFR levels from biphasic curve fitting. For the EC formulation, 24-hour REIs were calculated for irrigation of grapes, harvesting and scouting of crops with low potential for dermal transfer, harvesting in fruit trees, and irrigation and packing of ornamentals. Also for the EC formulation, REIs greater than 24 hours were derived for harvesting grapes (3 days), harvesting crops with medium potential for dermal transfer (4 days), harvesting crops with high potential for dermal transfer (5 days), and scouting and irrigating crops with high potential for dermal transfer (2 days). For the WP formulation, 24-hour REIs were calculated for irrigation of grapes, harvesting and scouting of crops with low potential for dermal transfer, and irrigation and packing of ornamentals. However, for the WP formulation, REIs greater than 24 hours were derived for harvesting grapes (~30 days), harvesting crops with medium potential for dermal transfer (8 days), harvesting crops with high potential for dermal transfer (9 days), scouting and irrigating crops with high potential for dermal transfer (4 days), and harvesting in fruit trees (5 days).

In summary, we have proposed consideration of the biphasic kinetics of the DFR dissipation data in order to obtain a better predictive model for DFRs and for the resulting calculated REIs. In all cases, the  $r^2$  value for Phase 1 (the critical time range for the great majority of the calculated DFRs) indicates a better fit to the data than a simple log-linear fit across the entire time frame of DFR dissipation. In approximately half of the cases, the  $r^2$  value for Phase 2 is less than 0.70, which indicates the fit for this second phase is less than ideal. In these specific cases, other kinetic models could be examined for alternative fit parameters. The REIs estimated in this report are likely to overestimate central tendency reentry intervals. For example, because some of the transfer coefficient (TC) values (e.g., for harvesting medium and high crops) represent the upper end of the range of the ARTF values, the REIs for these worker reentry activities may be artificially high. Furthermore, some of the TC values for a given worker reentry activity may be distributed in a lognormal fashion, in which case the geometric mean value would be a more appropriate measure of central tendency. Additional refinements in the REI estimates associated with these formulations may result in shorter allowable reentry intervals than indicated in this report. These refinements include, but are not necessarily limited to (1) formal statistical re-fitting of the data; (2) focusing on Phase 1 of the dissipation curve only (the most relevant portion for most cases), thus ignoring Phase 2; and (3) use of geometric mean TC values from the ARTF data for central tendency values.

## II. INTRODUCTION

This report presents the results of a screening-level worker reentry exposure assessment for Endosulfan [6,7,8,9,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide] (CAS No. 115-29-7), which is the active ingredient (a.i.) in the emulsifiable concentrate (EC) and wettable powder (WP) formulations being supported by the Endosulfan Task Force (ETF). Endosulfan formulations supported by the ETF are used to control insects in a variety of agricultural crops (including, for example, peaches, apples, melons, grapes, sweet corn, lettuce, potatoes, cauliflower, carrots, cotton, beans, strawberries, tobacco, tomatoes), commercially-grown trees and shrubs, and commercially-grown greenhouse tomatoes. This assessment focuses primarily on development of alternative reentry intervals associated with worker reentry into treated fields following application via airblast, groundboom, chemigation, and aerial methods at the maximum proposed label rate.

This assessment relies on dislodgeable foliar residue (DFR) data on endosulfan from studies conducted by member companies of the Endosulfan Task Force (ETF) on melons, peaches, and grapes. While these data were provided to the Agency, we disagree with the way in which the Agency has used these data, i.e., using the data on the wettable powder formulation to represent residue decline behavior for the EC formulation. In calculating Restricted Entry Intervals (REIs), also known as “reentry intervals,” the Agency has selectively applied the DFR data using transfer coefficient (TC) default values, which are inappropriate given the availability of crop-specific/task-specific TC values from the Agricultural Reentry Task Force (ARTF). The toxicological benchmark used in this assessment for dermal exposure was based on a 21-day dermal study in rats, from which the most appropriate NOEL of 9 mg/kg/day was identified by the Task Force (this was addressed by the ETF in further detail in a separate weight-of-evidence submission to the Agency; Aventis 2000). In contrast, the Agency applied the 3 mg/kg/day NOEL using an interspecies uncertainty factor (UF) of 10, and an intraspecies UF of 10, for a total uncertainty factor of 100 (the Agency correctly did not apply the additional FQPA uncertainty factor of 3 to the worker reentry assessment).

Accordingly, new estimates of reentry intervals for example crop-type/work activity combinations are calculated in this report using (1) formulation specific DFR dissipation data; (2) crop-specific label rates; (3) the most appropriate ARTF transfer coefficient (TC) values; (4) the proposed NOEL of 9 mg/kg/day; and (5) a total uncertainty factor of 100. The REIs estimated in the assessment take into account the base set of personal protective equipment (PPE) incorporated into the ARTF transfer coefficients.

## III. TOXICOLOGY AND ENDPOINT SELECTION

The specific position of the Endosulfan Task Force with respect to toxicology issues has been provided as part of the 30-day response to the Agency’s proposed risk assessment (USEPA 2000a) for the Reregistration Eligibility Decision (RED) document on endosulfan (Aventis 2000). There are four 21-day dermal studies in rats on endosulfan products. Two of these studies involve technical material (Acc. No. 257682/257683 and Acc. No. 257684/257685), one involves an endosulfan preparation of 49.5 percent purity (MRID No. 41048506), and a fourth study in rats involves an emulsifiable formulation (MRID No. 41048505). The emulsifiable

formulation is the most frequently used commercial product containing endosulfan. All four studies were conducted using the same strain of rat, the same dosing period (21 days), and the same exposure route (dermal), and have been reviewed and accepted as guideline studies by the Agency.

In the study selected by the Agency to establish the dermal NOEL (Acc. No. 257684/257685), the Agency cited two observed effects at 9 mg/kg/day — increased mortality in males and liver abnormalities in both sexes. The increased mortality consisted of two of six males at the 9 mg/kg/day level that died on Days 5 and 8, respectively. Necropsy revealed that the first male's testes, spleen, and thymus were significantly reduced in size (i.e., immature) with no evidence of inflammation and/or atrophy. The second male also demonstrated marked reduction in size of the testes, seminal vesicles and liver, also without signs of inflammation or atrophy. These effects were considered evidence of pre-existing developmental disturbances that were unrelated to treatment. Further, because no mortalities were observed in male rats at the next highest dose of 27 mg/kg/day, nor in the other three dermal studies until a dose of 81 mg/kg/day was attained, the 2 deaths at the 9 mg/kg/day level do not appear to be treatment-related. In addition, the severity of the liver abnormalities (enlargement of parenchymal cells in peripheral sections, loss of cytoplasmic basophilia, isolated cell necrosis, and frequent mitosis) cited by the Agency for the 9 mg/kg/day dose level were considered "very slight" by the Agency's pathologist. These effects were only observed in a few animals and were unrelated to dose level or gender.

Based on this evaluation, the Endosulfan Task Force (ETF) firmly believes that the most appropriate NOAEL for the study selected by the Agency is 9 mg/kg/day. In addition, if all four available subchronic dermal studies for endosulfan are evaluated as a group, it is the contention of the Task Force that the weight-of-evidence clearly supports a NOAEL of 9 mg/kg/day. Therefore, for the evaluation of short-term and intermediate-term dermal exposures, a NOAEL of 9 mg/kg/day is used in this assessment.

#### **IV. DESCRIPTION OF LABELS AND PRODUCT USE**

The proposed product labels are for Phaser<sup>®</sup> 3EC [USEPA Reg. No. 264-638], which is an emulsifiable concentrate formulations containing 3.0 lbs of endosulfan per gallon of formulation, and for Phaser<sup>®</sup> 50WSB [USEPA Reg. No. 264-656], which contains 50 percent active ingredient in wettable powder form in water soluble bags. These formulations are used to control insects in a variety of agricultural crops (including, for example, melons, peaches, apples, grapes, sweet corn, lettuce, potatoes, carrots, cauliflower, cotton, beans, strawberries, tobacco, tomatoes), commercially-grown trees and shrubs, and commercially-grown greenhouse tomatoes. The EC formulation is proposed for use at an application rate ranging from (0.5 to 2.5 lbs a.i./acre), depending on the crop type and pest type. The 50WSB formulation, which is a wettable powder formulation packaged in water soluble bags, is proposed for use at label application rates ranging from 1 to 5 lbs formulation/acre (0.5 to 2.5 lbs a.i./acre). The general application methods will be groundboom and aerial application to row crops and airblast application to tree crops.

## V. TECHNICAL APPROACH

### A. SUMMARY OF DISLODGEABLE FOLIAR RESIDUE (DFR) DATA

(1). *Overview.* A dissipation study for foliar dislodgeable residues of endosulfan associated with use of Phaser<sup>®</sup> 3EC and Phaser<sup>®</sup> 50WSB on melons, peaches, and grapes (AgrEvo 1997) has been submitted to the Agency (MRID No. 444031-02). In this study, the test substance consisting of the end use products was applied twice at one-week intervals in the case of melons and grapes, and once on peaches. The use rate for each application was in all cases 1 lb a.i./acre for melons, 1.5 lb a.i./acre for grapes and 3 lb a.i./acre for peaches. The three crops were maintained using standard methods, which included supplemental moisture by furrow irrigation. Foliar samples were collected at 0, 1, 3, 5, and 7 days after the first application, and 0, 1, 3, 5, 7, 10, 14, 17, 21, 24, and 28 days after the second application. The duplicate leaf samples consisted of 5 cm<sup>2</sup> punches of untreated (control) foliage and composited 5 cm<sup>2</sup> punches of treated foliage representing a total of 200 cm<sup>2</sup> of total leaf surface area. Endosulfan residues were dislodged from the leaf samples with 3 washes containing 50 ml of 0.012 percent Aerosol OT. Analytes were extracted from the pooled dislodging solution using 100 ml hexane. The detected amounts of residue are shown in Table 2.

(2). *Form of the DFR Dissipation Curves.* Despite (1) clear evidence in the DFR study (AgrEvo 1997) that the DFR dissipation data are biphasic for both the EC and WP formulations, and (2) demonstration of significantly higher foliar residues for the WP formulation compared to the EC formulation, the Agency chose to use a log-linear fit of the data across the entire time frame of dissipation for the WP formulation to represent both formulation types. However, the DFR study report submitted by the registrant indicates that relatively mediocre correlation coefficients (for example, 0.71 for peaches, 0.52 for grapes, and 0.76 for melons for the EC formulation) were obtained when the data were fit to a single log-linear line across the entire time-frame of the DFR data. This suggests that an adequate fit was not obtained using this approach. Nonetheless, EPA proceeded to use this approach in its HED assessment (USEPA 2000a).

**Table 2. Measured Dislodgeable Foliar Residues of Endosulfan in Melons, Peaches, and Grapes**

Application	Days Post-Application	Dislodgeable Foliar Residues (DFRs) <sup>a</sup> ( $\mu\text{g}/\text{cm}^2$ )					
		Melons		Peaches <sup>b</sup>		Grapes	
		EC	WP	EC	WP	EC	WP
1	0	0.70	1.77	---	---	0.61	1.51
	1	0.21	0.72	---	---	0.26	0.90
	3	0.05	0.22	---	---	0.08	0.61
	5	0.05	0.19	---	---	0.06	0.39
	7	0.04	0.11	---	---	0.04	0.29
2	0	1.23	1.00	0.46	1.02	0.71	1.32
	1	0.54	1.14	0.16	0.55	0.31	1.36
	3	0.15	0.53	0.09	0.43	0.11	0.51
	5	0.09	0.32	0.07	0.30	0.09	0.74
	7	0.06	0.18	0.04	0.22	0.03	0.28
	10	0.05	0.12	0.03	0.16	0.02	0.20
	14	0.05	0.07	0.03	0.11	0.04	0.24
	17	0.03	0.04	0.03	0.10	0.05	0.30
	21	0.02	0.02	0.05	0.09	0.02	0.20
	24	0.02	0.04	0.02	0.07	0.04	0.19
	28	0.02	0.03	0.01	0.04	< 0.01 <sup>c</sup>	0.13

<sup>a</sup> DFR residues from crops resulting from application of Phaser<sup>®</sup>EC or Phaser<sup>®</sup>WP; residue values shown are averages of triplicate sample taken at each sample interval.

<sup>b</sup> Peaches received only one application of test formulation.

<sup>c</sup> DFR value is below the limit of quantification ( $0.01\mu\text{g}/\text{cm}^2$ ).

If data are plotted in a log-linear fashion (i.e.,  $\ln$  [DFR] vs. time), the biphasic nature of the dissipation curve is readily apparent. With a compound like endosulfan, which displays a biphasic dissipation curve, there is a distinct initial rapid decline phase (“Phase 1”), possibly representing transformation processes on the surface of the leaves, followed by a much slower decline phase (“Phase 2”), possibly representing uptake by the plant or slower transformation processes. For example, if the data for the EC or WP formulation from the study report are plotted in a log-linear form, the DFR data suggest a “hockey stick” type of plot rather than a single straight line plot. This type of behavior may also be explained, in part, by the presence of the 2 isomers of endosulfan ( $\alpha$  and  $\beta$ ) which may have different rates for different dissipation processes (e.g., volatilization).

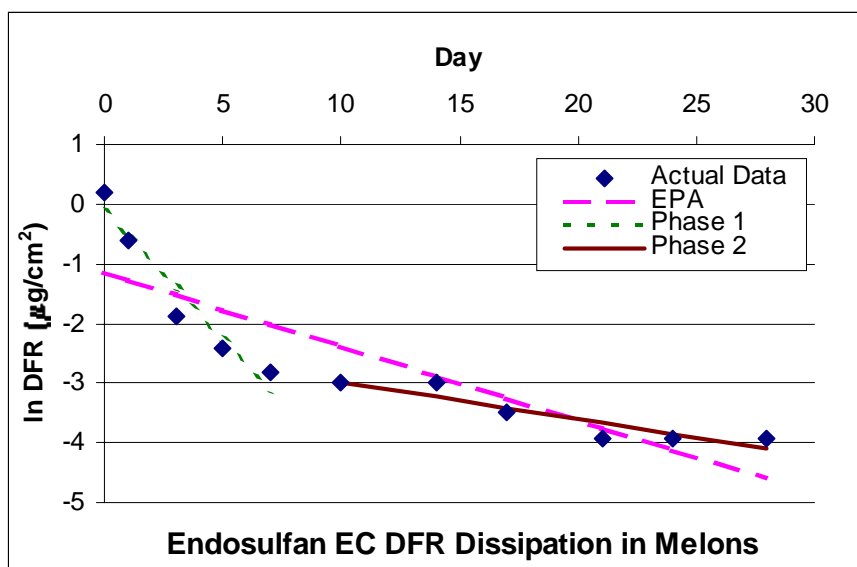
The biphasic plot for endosulfan DFR dissipation on melon foliage has a Phase 1 half-life ( $t_{1/2}$ ) of 0.7 days and a Phase 2 half-life of 8.6 days for the EC formulation (see Figure 1). Across the three crop types studied (melons, peaches, and grapes), the Phase 1 half-life is more than one order of magnitude shorter than the Phase 2 half-life for a given crop/formulation type combination. Interestingly, the Phase 1 half-life is longer for the WP formulation by about a factor of 3 compared to the Phase 1 half-life for the EC formulation in the case of 2 of the crop types (melons and grapes). The breakpoint between the 2 phases appears to be approximately Day 7 post-application for the EC formulation, and Day 10 post-application for the WP formulation. These data are shown below in Table 3.

The degree of divergence of the Agency’s predictive model (based on a log-linear fit across the entire residue dissipation time frame) from the measured endosulfan DFR values for Phaser WP can be observed when one examines Table 11 from the HED document (USEPA, 2000a) to the measured values from the DFR study. For example, the DFR value estimated by the Agency for endosulfan WP on melons in California was  $0.70 \text{ ug/cm}^2$  on day 0 while the measured DFR was  $1.0 \text{ ug/cm}^2$  (a biphasic approach predicts a value of  $1.1 \text{ ug/cm}^2$ ). The DFR value estimated by the Agency on day 10 was  $0.18 \text{ ug/cm}^2$ , but the measured DFR was  $0.12 \text{ ug/cm}^2$  (a biphasic approach predicts a value of  $0.10 \text{ ug/cm}^2$ ). Much of the error in the Agency’s estimating  $t_{1/2}$  with a single log-linear fit occurred in Phase 1, which happens to be the critical time for estimating most REIs. The implications for the estimated REI are significant. For example, the REI for harvesting peaches is calculated to be 1 day and 4 days for the EC and WP formulations, respectively, when the data are properly fit and a number of other changes are made, compared to 19 days and 32 days for the EC and WP formulations, respectively, as determined by EPA.

**Table 3. Half-Life Estimates Based on Biphasic (2-Compartment) Kinetics (Agrevo 1997)**

Formulation Type	Crop	Foliar Dissipation Half-Life (Days)	
		Rapid-Phase (Phase 1)	Slow-Phase (Phase 2)
EC	Melons	0.7	8.6
	Peaches	0.4	10.5
	Grapes	0.7	11.1
WP	Melons	2.9	2,240
	Peaches	0.3	6.2
	Grapes	2.5	84.8

**Figure 1. Regression of Endosulfan Melon DFR Data on Time for EC Formulation**



(3) Regression Analysis of the Chemical-Specific DFR Data. For the purposes of this assessment, a regression analysis was conducted using the natural log-transformed DFR data and biphasic kinetics, based on the apparent “break-points” in the curves representing the shift from the initial rapid phase (Phase 1) to the more gradual dissipation phase (Phase 2). To capture the initial phase (Phase 1), the natural log-transformed DFR data for Days 0 through 7 following the last application of the EC formulation, or Days 0 through 10 in the case of the WP formulation, were input into Microsoft Excel® to obtain the linear regression parameters for the equation  $y = mx + b$ , where:

y	=	the natural log of the DFR value on Day x
x	=	the number of days post-application
m	=	the slope of the regression line
b	=	constant

To capture the second phase (Phase 2), the natural log-transformed DFR data for Days 8 through 28 following the last application of EC formulation, or Days 11 through 28 for the WP formulation, were input Microsoft Excel® to obtain the linear regression parameters. The regression parameters are shown below in Table 4 for the following cases: (1) Case I: log-linear fit across all data points (i.e., identical to the Agency’s approach); (2) Case II: Phase 1 of biphasic kinetics including data for Days 0 through 7; (3) Case III: Phase 2 of biphasic kinetics including data for Days 8 through 28; (4) Case IV: Phase 1 of biphasic kinetics including data for Days 0 through 10; and (5) Case V: Phase 2 of biphasic kinetics including data for Days 11 through 28. Plots of the formulation-specific/crop-specific dissipation curves for Cases I, II, and III for the EC formulation and for Cases I, IV, and V for the WP formulation are shown in Attachment A. The results for each formulation type/crop types combination are summarized and interpreted below.

**Peaches** - Dislodgeable endosulfan residues were generally higher on WP-treated foliage than on EC-treated foliage, although the rates of dissipation were very similar. The mean residues found on Day 0 after application for the EC and WP formulations were  $0.46 \mu\text{g}/\text{cm}^2$  and  $1.02 \mu\text{g}/\text{cm}^2$ , respectively. By Day 21, the dislodgeable residues of endosulfan on the foliage had reduced to  $0.05 \mu\text{g}/\text{cm}^2$  and  $0.09 \mu\text{g}/\text{cm}^2$  for the EC and WP formulations, respectively. When a linear regression was performed on the natural log-transformed DFR data over the entire time course of the dissipation (i.e., Days 0 through 28) for Phaser® EC, slope (m) is -0.09131 and the y-intercept (b) is -1.91431. When the biphasic kinetics are accounted for, and the natural log-transformed DFR data for Days 0 through 7 are input into a linear regression, the slope and intercept for Phase 1 are -0.30548 and -1.20145, respectively. As indicated by the  $r^2$  value of 0.88694, consideration of the biphasic kinetics for Days 0 through 7 provides a better fit of the data than either (1) the simple linear regression across all the data points; or (2) fitting of the Phase 1 data based on Days 0 through 10, which may take the curve past the break point of Phase 1 and Phase 2. When a linear regression was performed on the natural log-transformed DFR data over the entire time course of the dissipation (i.e., Days 0 through 28) for Phaser® WP, slope (m) is -0.09728

**Table 4. Regression Parameters for 5 Cases for Fitting the Endosulfan DFR Data**

Formulation Type	Crop	Regression Parameter <sup>a</sup>	Case Description for Regression of Endosulfan DFR Data <sup>b</sup>				
			Case I	Case II	Case III	Case IV	Case V
EC	Melons	Slope	-0.12341	-0.42539	-0.062000	-0.31398	-0.06329
		Intercept	-1.15627	-0.14429	-2.3611	-0.39332	-2.33132
		<b>R<sup>2</sup></b>	<b>0.760823</b>	<b>0.927099</b>	<b>0.838204</b>	<b>0.852126</b>	<b>0.751366</b>
	Peaches	Slope	-0.09131	-0.30549	-0.04951	-0.24593	-0.07415
		Intercept	-1.91431	-1.20145	-2.73132	-1.3346	-2.16294
		<b>R<sup>2</sup></b>	<b>0.707732</b>	<b>0.88694</b>	<b>0.367451</b>	<b>0.876897</b>	<b>0.470485</b>
	Grapes	Slope	-0.10238	-0.41296	-0.03669	-0.34757	-0.08932
		Intercept	-1.65347	-0.60561	-2.94675	-0.75179	-1.73238
		<b>R<sup>2</sup></b>	<b>0.620471</b>	<b>0.950206</b>	<b>0.160114</b>	<b>0.939717</b>	<b>0.555678</b>
WP	Melons	Slope	-0.13955	-0.26611	-0.07573	-0.23744	-0.04898
		Intercept	-0.35023	0.179945	-1.66707	0.115856	-2.28424
		<b>R<sup>2</sup></b>	<b>0.883775</b>	<b>0.966314</b>	<b>0.628731</b>	<b>0.968481</b>	<b>0.35041</b>
	Peaches	Slope	-0.09728	-0.19818	-0.06794	-0.17093	-0.06847
		Intercept	-0.55653	-0.19386	-1.14718	-0.25477	-1.13506
		<b>R<sup>2</sup></b>	<b>0.925047</b>	<b>0.930679</b>	<b>0.92514</b>	<b>0.936614</b>	<b>0.875184</b>
	Grapes	Slope	-0.07169	-0.20761	-0.02662	-0.1969	-0.04924
		Intercept	-0.17214	0.33188	-1.08607	0.307953	-0.56415
		<b>R<sup>2</sup></b>	<b>0.739024</b>	<b>0.792659</b>	<b>0.40595</b>	<b>0.880108</b>	<b>0.776054</b>

<sup>a</sup> Regression parameters for linear regression of natural log-transformed DFR data with number of days following application.

<sup>b</sup> Description of Cases: Case I = linear regression across all data points, Days 0 through 28 (USEPA approach).  
Case II = linear regression across first phase of biphasic kinetics, Days 0 through 7.  
Case III = linear regression across second phase of biphasic kinetics, Days 8 through 28.  
Case IV = linear regression across first phase of biphasic kinetics, Days 0 through 10.  
Case V = linear regression across second phase of biphasic kinetics, Days 11 through 28.

and the y-intercept (b) is -0.55653. When the biphasic kinetics are accounted for, and the natural log-transformed DFR data for Days 0 through 10 are input into a linear regression, the slope and intercept for Phase 1 are -0.17093 and -0.25477. This provides the highest  $r^2$  value of 0.936614. Thus, consideration of the biphasic kinetics for Days 0 through 10 provides a better fit of the data for the WP formulation than either (1) the simple linear regression across all the data points; or (2) fitting of the Phase 1 data based on Days 0 through 7.

**Grapes** - As with peaches, dislodgeable endosulfan residues were generally higher on WP-treated foliage than on EC-treated foliage, although the rates of dissipation were not as similar as with peaches. The mean residues found on Day 0 after application for the EC and WP formulations were  $0.71 \mu\text{g}/\text{cm}^2$  and  $1.32 \mu\text{g}/\text{cm}^2$ , respectively. By Day 21 after the second application, the dislodgeable residues of endosulfan on the foliage had reduced to  $0.02 \mu\text{g}/\text{cm}^2$  and  $0.20 \mu\text{g}/\text{cm}^2$  for the EC and WP formulations, respectively. When a linear regression was performed on the natural log-transformed DFR data over the entire time course of the dissipation (i.e., Days 0 through 28) for Phaser<sup>®</sup> EC, the slope (m) is -0.10238, the y-intercept (b) is -1.65347, and the  $r^2$  value is 0.620471. When the biphasic kinetics are accounted for, and the natural log-transformed DFR data for Days 0 through 7 are input into a linear regression, the slope and intercept for Phase 1 are -0.41296 and -0.60561, respectively. As indicated by the  $r^2$  value of 0.950206, consideration of the biphasic kinetics for Days 0 through 7 provides a better fit of the data than either (1) the simple linear regression across all the data points; or (2) fitting of the Phase 1 data based on Days 0 through 10, which may take the curve past the break point of Phase 1 and Phase 2. When a linear regression was performed on the natural log-transformed DFR data over the entire time course of the dissipation (i.e., Days 0 through 28) for Phaser<sup>®</sup> WP, slope (m) is -0.07169, the y-intercept (b) is -0.17214, and the  $r^2$  value is 0.739024. When the biphasic kinetics are accounted for, and the natural log-transformed DFR data for Days 0 through 10 are input into a linear regression, the slope and intercept for Phase 1 for the WP formulation are -0.1969 and 0.307953, respectively. This approach provides the highest  $r^2$  value of 0.880108. Thus, consideration of the biphasic kinetics for Days 0 through 10 provides a better fit of the data for the WP formulation than either (1) the simple linear regression across all the data points; or (2) fitting of the Phase 1 data based on Days 0 through 7.

**Melons** - As with peaches and grapes, dislodgeable endosulfan residues were generally higher on WP-treated foliage than on EC-treated foliage. The mean residues found on Day 0 after application for the EC and WP formulations were  $1.23 \mu\text{g}/\text{cm}^2$  and  $1.00 \mu\text{g}/\text{cm}^2$ , respectively. This is the only day on which the DFR value for the EC-treated foliage exceeds that for the WP-treated foliage, and may represent a measurement anomaly. By Day 21 after the second application, the dislodgeable residues of endosulfan on the melon foliage had reduced to  $0.02 \mu\text{g}/\text{cm}^2$  for both formulation types. When a linear regression was performed on the natural log-transformed DFR data over the entire time course of the dissipation (i.e., Days 0 through 28) for Phaser<sup>®</sup> EC, the slope (m) is -0.12341, the y-intercept (b) is -1.15627, and the  $r^2$  value is 0.760823. When the biphasic kinetics are accounted for, and the natural log-transformed DFR data for Days 0 through 7 are input into a linear regression, the slope and intercept for Phase 1 are -0.42539 and -0.14429, respectively. As indicated by the  $r^2$  value of 0.927099, consideration of the

biphasic kinetics for Days 0 through 7 provides a better fit of the data for the EC formulation than either (1) the simple linear regression across all the data points; or (2) fitting of the Phase 1 data based on Days 0 through 10, which may take the curve past the break point of Phase 1 and Phase 2. With regard to Phaser<sup>®</sup> WP, when a linear regression was performed on the natural log-transformed melon DFR data over the entire time course of the dissipation (i.e., Days 0 through 28), the slope (m) is -0.13955, the y-intercept (b) is -0.35023, and the  $r^2$  value is 0.883775. When the biphasic kinetics are accounted for, and the natural log-transformed DFR data for Days 0 through 10 are input into a linear regression, the slope and intercept for Phase 1 for the WP formulation are -0.23744 and 0.115856, respectively. This approach provides the highest  $r^2$  value of 0.968481.

(4) Predicted Daily DFR Levels Based on Biphasic Kinetics. Using the most appropriate regression equations, the predicted daily DFRs on foliage on Days 1 through 41 in the case of peaches, melons, grapes are shown in Tables 5 and 6 for the EC and WP formulations, respectively. Because the DFR studies on peaches, grapes, and melons were conducted at application rates of 3 lb a.i./acre, 1.5 lb a.i./acre, and 1.0 lb a.i./acre, respectively, which is consistent with the label-specified rates for these crops for Phaser<sup>®</sup> EC and Phaser<sup>®</sup> WP, no adjustment in the predicted daily DFR values was necessary. The following regression equations were used describe the predicted endosulfan residues for the EC formulation:

- Peaches, Phase 1:  $\ln(\text{DFR}_p) = (-0.30549 * t) - 1.20145$  [ $r^2 = 0.88694$ ]
- Peaches, Phase 2:  $\ln(\text{DFR}_p) = (-0.04951 * t) - 2.73132$  [ $r^2 = 0.367451$ ]
- Melons, Phase 1:  $\ln(\text{DFR}_p) = (-0.42539 * t) - 0.14429$  [ $r^2 = 0.927099$ ]
- Melons, Phase 2:  $\ln(\text{DFR}_p) = (-0.06200 * t) - 2.3611$  [ $r^2 = 0.838204$ ]
- Grapes, Phase 1:  $\ln(\text{DFR}_p) = (-0.41296 * t) - 0.60561$  [ $r^2 = 0.950206$ ]
- Grapes, Phase 2:  $\ln(\text{DFR}_p) = (-0.03669 * t) - 2.94675$  [ $r^2 = 0.160114$ ]

The following regression equations were used to describe the predicted endosulfan residues for the WP formulation:

- Peaches, Phase 1:  $\ln(\text{DFR}_p) = (-0.17093 * t) - 0.25477$  [ $r^2 = 0.936614$ ]
- Peaches, Phase 2:  $\ln(\text{DFR}_p) = (-0.06847 * t) - 1.13506$  [ $r^2 = 0.875184$ ]
- Melons, Phase 1:  $\ln(\text{DFR}_p) = (-0.23744 * t) + 0.11586$  [ $r^2 = 0.968481$ ]
- Melons, Phase 2:  $\ln(\text{DFR}_p) = (-0.04898 * t) - 2.28424$  [ $r^2 = 0.35041$ ]
- Grapes, Phase 1:  $\ln(\text{DFR}_p) = (-0.1969 * t) + 0.307953$  [ $r^2 = 0.880108$ ]
- Grapes, Phase 2:  $\ln(\text{DFR}_p) = (-0.04924 * t) - 0.56416$  [ $r^2 = 0.776054$ ]

**Table 5. Predicted DFR Levels ( $\mu\text{g}/\text{cm}^2$ ) Based on Regression Equations for Phaser® EC**

Sample Interval <sup>a</sup>	Predicted DFR – Biphasic Kinetics <sup>b</sup>			Sample Interval <sup>a</sup>	Predicted DFR – Biphasic Kinetics <sup>b</sup>		
	Grapes	Peaches	Melons		Grapes	Peaches	Melons
0	0.55	0.30	0.87	21	0.024	0.023	0.026
1	0.36	0.22	0.57	22	0.023	0.022	0.024
2	0.24	0.16	0.37	23	0.023	0.021	0.023
3	0.16	0.12	0.24	24	0.022	0.020	0.021
4	0.10	0.089	0.16	25	0.021	0.019	0.020
5	0.069	0.065	0.10	26	0.020	0.018	0.019
6	0.046	0.048	0.067	27	0.019	0.017	0.018
7	0.030	0.035	0.044	28	0.019	0.016	0.017
8	0.039	0.044	0.057	29	0.018	0.015	0.016
9	0.038	0.042	0.054	30	0.017	0.015	0.015
10	0.036	0.040	0.051	31	0.017	0.014	0.014
11	0.035	0.038	0.048	32	0.016	0.013	0.013
12	0.034	0.036	0.045	33	0.016	0.013	0.012
13	0.033	0.034	0.042	34	0.015	0.012	0.011
14	0.031	0.033	0.040	35	0.015	0.012	0.011
15	0.030	0.031	0.037	36	0.014	0.011	0.010
16	0.029	0.029	0.035	37	0.014	0.010	0.0095
17	0.028	0.028	0.033	38	0.013	0.0099	0.0089
18	0.027	0.027	0.031	39	0.013	0.0094	0.0084
19	0.026	0.025	0.029	40	0.012	0.0090	0.0079
20	0.025	0.024	0.027	41	0.012	0.0086	0.0074

<sup>a</sup> Days after treatment

<sup>b</sup> Based on the following regression equations:

For grapes,  $\ln(\text{DFR}_p) = (-0.41296 * t) - 0.60561$  [ $r^2 = 0.950206$ ] for Days 0 through 7 (Phase 1)

and  $\ln(\text{DFR}_p) = (-0.03669 * t) - 2.94675$  [ $r^2 = 0.160114$ ] Days 8 through 41 (Phase 2).

For peaches,  $\ln(\text{DFR}_p) = (-0.30549 * t) - 1.20145$  [ $r^2 = 0.88694$ ] for Days 0 through 7 (Phase 1)

and  $\ln(\text{DFR}_p) = (-0.04951 * t) - 2.73132$  [ $r^2 = 0.367451$ ] for Days 8 through 41 (Phase 2).

For melons,  $\ln(\text{DFR}_p) = (-0.42539 * t) - 0.14429$  [ $r^2 = 0.927099$ ] for Days 0 through 7 (Phase 1)

and  $\ln(\text{DFR}_p) = (-0.06200 * t) - 2.361$  [ $r^2 = 0.838204$ ] for Days 8 through 41 (Phase 2).

**Table 6. Predicted DFR Levels ( $\mu\text{g}/\text{cm}^2$ ) Based on Regression Equations for Phaser® WP**

Sample Interval <sup>a</sup>	Predicted DFR – Biphasic Kinetics <sup>b</sup>			Sample Interval <sup>a</sup>	Predicted DFR – Biphasic Kinetics <sup>b</sup>		
	Grapes	Peaches	Melons		Grapes	Peaches	Melons
0	1.36	0.78	1.12	21	0.20	0.076	0.036
1	1.12	0.65	0.89	22	0.19	0.071	0.035
2	0.92	0.55	0.70	23	0.18	0.067	0.033
3	0.75	0.46	0.55	24	0.17	0.062	0.031
4	0.62	0.39	0.43	25	0.17	0.058	0.030
5	0.51	0.33	0.34	26	0.16	0.054	0.029
6	0.42	0.28	0.27	27	0.15	0.051	0.027
7	0.34	0.23	0.21	28	0.14	0.047	0.026
8	0.28	0.20	0.17	29	0.14	0.044	0.025
9	0.23	0.17	0.13	30	0.13	0.041	0.023
10	0.19	0.14	0.10	31	0.12	0.038	0.022
11	0.33	0.15	0.059	32	0.12	0.036	0.021
12	0.32	0.14	0.057	33	0.11	0.034	0.020
13	0.30	0.13	0.054	34	0.11	0.031	0.019
14	0.29	0.12	0.051	35	0.10	0.029	0.018
15	0.27	0.12	0.049	36	0.097	0.027	0.017
16	0.26	0.11	0.047	37	0.092	0.026	0.017
17	0.25	0.10	0.044	38	0.088	0.024	0.016
18	0.23	0.094	0.042	39	0.083	0.022	0.015
19	0.22	0.088	0.040	40	0.079	0.021	0.014
20	0.21	0.082	0.038	41	0.076	0.019	0.014

<sup>a</sup> Days after treatment<sup>b</sup> Based on the following regression equations:

For grapes,  $\ln(\text{DFR}_p) = (-0.1969 * t) + 0.307953$  [ $r^2 = 0.880108$ ] for Days 0 through 10 (Phase 1)  
and  $\ln(\text{DFR}_p) = (-0.04924 * t) - 0.56416$  [ $r^2 = 0.776054$ ] for Days 11 through 41 (Phase 2).

For peaches,  $\ln(\text{DFR}_p) = (-0.17093 * t) - 0.25477$  [ $r^2 = 0.936614$ ] for Days 0 through 10 (Phase 1)  
and  $\ln(\text{DFR}_p) = (-0.06847 * t) - 1.13506$  [ $r^2 = 0.875184$ ] for Days 11 through 41 (Phase 2).

For melons,  $\ln(\text{DFR}_p) = (-0.23744 * t) + 0.115856$  [ $r^2 = 0.968481$ ] for Days 0 through 10 (Phase 1)  
and  $\ln(\text{DFR}_p) = (-0.04898 * t) - 2.28424$  [ $r^2 = 0.35041$ ] for Days 11 through 41 (Phase 2).

## B. SUMMARY OF TRANSFER COEFFICIENTS

The transfer coefficient is the conceptual term that links dislodgeable foliar residues (DFRs) to worker reentry exposures. The transfer coefficient for dermal exposure is directly related to the degree of contact between the crop and worker (which is dependent upon the height and density of the crop) and the nature of the worker contact(s) for specific work activities (e.g., weeding, pruning, cutting, sorting/bundling, harvesting). The transfer coefficient (TC) can be thought of as the surface area of treated foliage contacted by the worker per hour. Thus, the TC is work task-specific and crop-specific (or crop cluster-specific). The transfer coefficient (TC) is calculated as follows:

$$TC (cm^2/hr) = [Exposure (\mu g/hr)]/[DFR (\mu g/cm^2)] \quad [1]$$

It has been customary to use a default value of 5,000 cm<sup>2</sup>/hr and 10,000 cm<sup>2</sup>/hr to represent the transfer coefficient when specific values are unknown. This arose in part from the work of Zweig et al. (1985), who reported an average TC of about 5,000 cm<sup>2</sup>/hr across the studies he examined based on one-sided DFR values.

The Agricultural Reentry Task Force (ARTF) has carried out a number of field studies for various worker reentry activities in different crops to empirically determine the appropriate transfer coefficients. The ARTF has also been able to group various crops and activities according to potential dermal exposure (low, medium, high) when consideration is given to correlated variables such as crop height and extent of foliage. For example, based on this grouping exercise, the ARTF has placed harvesting melons in a low exposure cluster. Because the Endosulfan Task Force (ETF) member companies are also members of the ARTF, the ETF has chosen to cite and utilize TC data from the ARTF in this assessment. For example, while no actual study to determine a transfer coefficient for harvesting melons has been completed to date, ARTF studies on similar activities suggest that TC values for melon harvesting should range roughly between 100 and 1,000 cm<sup>2</sup>/hr. For the purpose of this assessment, a value of 946 has been selected for the TC for harvesting crops that have low potential for transfer of residues to skin.

In the HED assessment on endosulfan (USEPA 2000a), the Agency has chosen to use default values for transfer coefficients from a policy memo (USEPA 1998). As stated in the background section of this memo, the default values are to be used only when no agricultural postapplication exposure data are available on a given crop for the work activity of interest. Because the ARTF data are available to be used in this assessment of endosulfan, it is the position of the ETF that the ARTF TC values should be used by the Agency instead of the Agency default values. Despite some of the inherent variability that occurs between the results for studies on the same crop/work activity; the ETF believes that the results on one or more studies supercedes the Agency defaults.

Furthermore, the Transfer Coefficient (TC) defaults that the Agency used in the endosulfan assessment are not consistent with those used by the Agency in the cases of azinphosmethyl (USEPA, 1999a), chlorpyrifos (USEPA, 1999b) or acephate (USEPA, 2000b). As mentioned above, the TCs used in the endosulfan RED were referenced to an EPA policy

memo (USEPA, 1998). However, the policy memo does not appear to be applied uniformly from one pesticide to the next, and the TCs recommended are not consistent with those based on recent studies conducted under GLP by the ARTF and most of those in the published literature. For instance, the maximum TC for melon harvesters used by the Agency appears to be roughly 2-fold higher than those from properly conducted reentry exposure studies developed by ARTF as shown in Table 7. Another cogent example of the difference between EPA's default TC and recently conducted studies is the TC for tree fruit harvesters. The Agency has used a TC default value of 10,000 cm<sup>2</sup>/hr for tree fruit harvesting, while ARTF has developed 8 studies with TCs ranging from 885 to 6891 cm<sup>2</sup>/hr. Thus, lower TC values are used in this assessment than in the USEPA HED assessment (USEPA 2000a), because they can be directly supported from the available data.

### **C. WORKER REENTRY EXPOSURE SCENARIOS AND ASSUMPTIONS**

Short-term and intermediate-term daily exposures were calculated to allow comparison to the daily exposures estimated by the Agency. The Endosulfan Task Force (ETF) agrees with the Agency that there are potential short-term and intermediate-term postapplication exposures related to a variety of activities for workers entering treated fields. The worker exposure scenarios addressed in this assessment include harvesting and irrigating grapes; scouting and harvesting of low-growing fruit and vegetable crops with low potential for dermal transfer of residues to workers, harvesting of field crops with medium potential for dermal transfer of residues to workers; scouting/irrigation and harvesting of field crops with high potential for dermal transfer of residues to workers; harvesting of fruit trees; and irrigation and packing of ornamentals.

Because of the multitude of crops potentially treated with Phaser<sup>®</sup> 3EC and Phaser<sup>®</sup> 50WSB, indicator crops/activities, application rate assumptions, and example transfer coefficients were used that are likely to be representative for post-application worker reentry exposures to endosulfan. The crop groups/activities assessed were selected because applicable residue data were available (see description of the relevant post-application dislodgeable foliar residue (DFR) study [MRID No. 444031-02] above); these are the same activity categories assumed by the Agency, and appropriate transfer coefficient data from the ARTF efforts were available. Accordingly, exposure assumptions could be made that would be inclusive of similar crop types and activities. A summary of the post-application worker reentry exposure scenarios is as follows:

**Table 7. EPA Transfer Coefficients (cm<sup>2</sup>/hr) Used in the Endosulfan HED Document (USEPA, 2000a), Range of ARTF Values, Comparison to ETF-Selected Transfer Coefficients and Resulting Conservatism**

Crop Type	Work Activity	Transfer Coefficients (cm <sup>2</sup> /hr)			Overestimation by EPA Relative to ETF Values	Comments
		EPA (Default)	ARTF (Measured)	Selected by ETF		
Grapes	Harvesting	15,000	2,928-6,840	5,350	2.8-fold	ETF value is mean of 70 replicates of grape harvesting and cane turning
	Irrigation	4,000	----	514	7.8-fold	ETF value is mean of 15 replicates of grape scouting
Low Crops	Harvesting	2,500	36-1,266	946	2.6-fold	ETF value is mean of 58 replicates of strawberry harvesting
	Scouting	1,000	----	528	1.9-fold	ETF value is mean of 35 replicates of pea and bean scouting
Medium Crops	Harvesting	4,000	611-4,290	4,290	----	ETF value is mean of 16 replicates of cauliflower harvesting
High Crops	Harvesting	10,000	885-6,891	6,309	1.6-fold	ETF value is mean of 63 replicates of tobacco harvesting/sweet corn scouting
	Scouting/Irrigating	4,000	----	1,983	2.0-fold	ETF value is mean of 41 replicates of cauliflower and cotton scouting
Fruit Trees	Harvesting	10,000	----	2,431	4.1-fold	ETF value is mean of 105 replicates of apple/peach harvesting & peach thinning
Ornamentals	Irrigation	4,000	----	89	45-fold	ETF value is mean of 10 replicates of peach proppers
	Packing	2,500	----	821	3.0-fold	ETF value is mean of 15 replicates of olive pruners



- (1) Harvesting activities for fruit and nut tree crops. This scenario is assumed to be representative of exposures associated with fruit and nut trees. DFR data for peaches were used, based on a study (MRID No. 444031-02) conducted at an application rate of 3 lb a.i./acre (single application). For Phaser<sup>®</sup> WP, the maximum application rate for fruit trees is 5 lb. formulation/acre (i.e., 2.5 lb a.i./acre); the maximum application rate for nut trees is 7.5 lb. formulation/acre (i.e., 3.75 lb a.i./acre). For Phaser<sup>®</sup> EC, the product label specifies that the maximum use rate of 3 lb a.i./year is not to be exceeded for any fruit or nut trees. Thus, exposure estimates based on DFR data obtained at a use rate of 3 lb a.i./acre should be generically representative for post-application worker reentry activities associated with harvesting fruit and nut trees. A dermal transfer coefficient (TC) of 2,431 cm<sup>2</sup>/hr was used from available ARTF data to represent harvesting activities associated with fruit and nut trees; this TC is the mean of 105 replicates of apple and peach harvesting and peach thinning. The ETF feels that this TC derived from recent ARTF data is a more valid value than the default of 10,000 cm<sup>2</sup>/hr used by the Agency.
- (2) Irrigating, harvesting, and other activities associated with grapes. This scenario is assumed to be representative for a wide variety of activities related to grapes. DFR data for grapes were used based on a study conducted at an application rate of 1.5 lb a.i./acre (MRID No. 444031-02). Because this application rate matches the maximum recommended label use rates for both Phaser<sup>®</sup> WP and Phaser<sup>®</sup> EC, exposure estimates based on DFR data obtained at a use rate of 1.5 lb a.i./acre should be generically representative for post-application worker reentry activities associated with grapes. Dermal transfer coefficients (TCs) of 5,350 cm<sup>2</sup>/hr and 514 cm<sup>2</sup>/hr were used from available ARTF data to represent harvesting and irrigation activities, respectively, associated with grapes. The TC for grape harvesting is the mean of 70 replicates of data for grape harvesting and cane turning. The TC for irrigation of grapes is the mean of 15 replicates of data for grape scouting, which should have exposure potential similar to that for irrigating grapes. The ETF feels that the TCs derived from ARTF data are more reliable values than defaults of 15,000 cm<sup>2</sup>/hr and 4,000 cm<sup>2</sup>/hr used by the Agency.
- (3) Harvesting, scouting, and irrigation of crops with low exposure potential. This scenario is based on activities associated with usually low-growing crops that are typically associated with low potential for dermal exposure. DFR data for melons were used based on a study conducted at an application rate of 1 lb a.i./acre (MRID No. 444031-02). For Phaser<sup>®</sup> WP, the maximum application rate for low crops such as peas, beans, strawberries, broccoli, celery, and collards is 2 lb. formulation/acre (i.e., 1.0 lb a.i./acre). For Phaser<sup>®</sup> EC, the product label specifies a maximum use rate of 1.0 lb a.i./acre for low crops. Because the application rate from the DFR study matches the maximum recommended label use rates for both Phaser<sup>®</sup> WP and Phaser<sup>®</sup> EC, exposure estimates based on DFR data obtained at a use rate of 1.0 lb a.i./acre should be generically representative for post-application worker reentry activities associated with low crops such as peas, beans, strawberries, broccoli, celery, and collards. Thus, unlike the approach taken by the Agency for low crops, no adjustment of the DFR

data is necessary. Dermal transfer coefficients (TCs) of 946 cm<sup>2</sup>/hr and 528 cm<sup>2</sup>/hr were used from available ARTF data to represent harvesting and scouting activities, respectively, associated with low crops. The TC for low crop harvesting is the mean of 58 replicates of data for strawberry harvesting. The TC for scouting of low crops is the mean of 35 replicates of data for scouting in pea and bean crops, which should have exposure potential similar to that for irrigating low crops. The ETF feels that these TC derived from recent ARTF data are more valid values than the defaults of 2,500 cm<sup>2</sup>/hr and 1,000 cm<sup>2</sup>/hr used by the Agency for harvesting and scouting in low crops, respectively.

- (4) Harvesting, scouting, and irrigation of crops with medium exposure potential. This scenario is based on activities associated with crops that are typically associated with medium potential for transfer of residues to skin. DFR data for melons were used based on a study conducted at an application rate of 1 lb a.i./acre (MRID No. 444031-02). For Phaser<sup>®</sup> WP, the maximum application rate for these crops is 2 lb. formulation/acre (i.e., 1.0 lb a.i./acre). For Phaser<sup>®</sup> EC, the product label specifies a maximum use rate of 1.0 lb a.i./acre for such crops. Because the application rate from the DFR study matches the maximum recommended label use rates for both Phaser<sup>®</sup> WP and Phaser<sup>®</sup> EC, exposure estimates based on DFR data obtained at a use rate of 1.0 lb a.i./acre should be generically representative for post-application worker reentry activities associated with such crops. Thus, unlike the approach taken by the Agency for low crops, no adjustment of the DFR data is necessary. A dermal transfer coefficient (TC) of 4,290 cm<sup>2</sup>/hr was used from available ARTF data to represent harvesting and scouting activities in these crops. The TC for harvesting crops associated with medium exposure potential is the mean of 16 replicates of data for cauliflower harvesting. This TC derived from recent ARTF data is essentially the same as the default of 4,000 cm<sup>2</sup>/hr used by the Agency for harvesting of medium crops.
- (5) Harvesting, scouting, and irrigating crops with high exposure potential. This scenario is based on activities associated with crops that are typically associated with high potential for dermal transfer of residues to workers reentering treated fields. DFR data for melons were used based on a study conducted at an application rate of 1 lb a.i./acre (MRID No. 444031-02). For Phaser<sup>®</sup> WP, the maximum application rate for such crops is 2 lb. formulation/acre (i.e., 1.0 lb a.i./acre). For Phaser<sup>®</sup> EC, the product label specifies a maximum use rate of 1.0 lb a.i./acre for these selected crops. Because the application rate from the DFR study matches the maximum recommended label use rates for both Phaser<sup>®</sup> WP and Phaser<sup>®</sup> EC, exposure estimates based on DFR data obtained at a use rate of 1.0 lb a.i./acre should be generically representative for post-application worker reentry activities associated with these crops. Thus, unlike the approach taken by the Agency for high crops, no adjustment of the DFR data is necessary. Dermal transfer coefficients (TCs) of 6,309 cm<sup>2</sup>/hr and 1,983 cm<sup>2</sup>/hr were used from available ARTF data to represent harvesting and scouting/irrigating activities, respectively, associated with these crops. The TC for harvesting is the mean of 63 replicates of data for harvesting of tobacco and sweet corn. The TC for scouting/irrigating is the mean of 41 replicates of data for scouting in cauliflower

and cotton, which should have exposure potential similar to that for irrigating these crops. The ETF feels that these TCs derived from recent ARTF data are more valid values than the defaults of 10,000 cm<sup>2</sup>/hr and 4,000 cm<sup>2</sup>/hr used by the Agency for harvesting and scouting/irrigating in these crops, respectively.

- (6) Irrigating and packing of ornamentals. This scenario is assumed to be representative of exposures associated with worker reentry activities in ornamental trees. DFR data for peaches were used, based on a study (MRID No. 444031-02) conducted at an application rate of 3 lb a.i./acre. For Phaser<sup>®</sup> WP, the maximum application rate for ornamental trees is 3 lb a.i./acre. For Phaser<sup>®</sup> EC, the product label specifies that the maximum use rate of 3.0 lb a.i./acre/year is not to be exceeded for ornamental plants. Thus, exposure estimates based on DFR data obtained at a use rate of 3.0 lb a.i./acre should be generically representative for post-application worker reentry activities associated with ornamental trees. Dermal transfer coefficients (TCs) of 89 cm<sup>2</sup>/hr and 821 cm<sup>2</sup>/hr were used from available ARTF data to represent irrigation and packing activities, respectively, associated with ornamental trees. The TC for irrigation is the mean of 10 replicates of data for peach proppers, and the TC for packing is the mean of 15 replicates of data for olive pruners. The ETF feels that these TCs derived from recent ARTF data are more valid values than the defaults of 4,000 cm<sup>2</sup>/hr and 2,500 cm<sup>2</sup>/hr used by the Agency to represent irrigation and packing, respectively, for ornamental trees.
- (7) Treating a greenhouse with a smoke canister. This use pattern, which is assessed in the HED document (USEPA, 2000a) is not relevant to either Phaser<sup>®</sup> WP or Phaser<sup>®</sup> EC formulations, and is, therefore, not addressed in this assessment.

#### **D. ESTIMATION OF WORKER REENTRY EXPOSURES TO ENDOSULFAN**

Short-term and intermediate term doses and margins of exposure (MOEs) were calculated as follows based on the formulation-specific crop-specific regression equations obtained considering the biphasic nature of the DFR dissipation curves (see Section V.A; Table 4):

$$ADD = [DFR_p \times TC \times ET \times (mg/1,000 \mu g)]/BW \quad [2]$$

where,

ADD	=	per-event average daily dose (mg/kg/day)
DFR <sub>p</sub>	=	predicted dislodgeable foliar residue value (μg/cm <sup>2</sup> )
TC	=	transfer coefficient for specific work activity (cm <sup>2</sup> /hr)
ET	=	exposure duration (8 hr/day)
BW	=	body weight (70 kg)

and,

$$MOE = NOEL/ADD \quad [3]$$

where,

MOE = margin of exposure (unitless)  
 NOEL = No-Observed-Effect-Level (9 mg/kg/day)  
 ADD = per-event average daily dose (mg/kg/day)

The estimated short-term and intermediate exposures on each potential day of reentry up to and including Day 41 for grapes and Day 20 for other crops, along with the MOEs, are shown in Attachment B.

## E. CALCULATION OF REENTRY INTERVALS (REIs)

The major risk mitigation tool for reducing worker reentry exposures is to restrict how soon workers may enter treated fields after application. Although there continues to be interest in other exposure reduction strategies (e.g., the use of protective clothing, reformulation and reduction in use rate), restricting the time of reentry by the use of reentry intervals is still the most widely used approach to prevent excessive exposure. This administrative measure to control worker exposure has evolved over a period of several decades, based on our understanding of the toxicology of pesticides and our ability to quantify worker exposure. A reentry interval is the minimum time (hrs, days) following application of a pesticide at which workers may safely reenter agricultural fields. The USEPA requires that a registrant specify a reentry interval on the product label. A reentry interval and supporting data are required by the USEPA under 40 CFR 158.390 to support the registration of each end-use product that is in Toxicity Category I, or if the active ingredient is neurotoxic, teratogenic, or oncogenic, or if adverse effects from worker reentry are reasonably anticipated based on anticipated use patterns, work practices, toxicological considerations, or epidemiological evidence and the results of a risk analysis based on a margin-of-safety approach (USEPA 1997). Current thinking is that the reentry interval should be exposure-based rather than driven by toxic response (Krieger 1995). The “Ambient Reentry Concentration Method” (USEPA 1997) is the basic method currently used in North America to set reentry intervals. This method takes into account the rate of dissipation of a pesticide on a particular crop, and is work task-specific, basing exposure on actual human studies in the crop of interest.

There are a number of sources of conservatism that can result in overestimates of reentry exposure, and overestimates of REIs. In order to remove the excess conservatism inherent in the Agency’s presentation of exposure and calculation of reentry intervals, several changes were made. As noted previously, our analysis of formulation-specific DFR data did not use the standard log-linear decay curve-fitting to force a single linear plot across the entire time frame of the study; rather the biphasic nature of the DFR data (leading to a “hockey stick” type of plot) was included in the analysis. Furthermore, the transfer coefficient (TC) defaults used by the Agency were replaced with more appropriate measured values from the ARTF data. In addition, we used the more appropriate NOEL of 9 mg/kg/day, the label-specific use rates, and a total uncertainty factor of 100. The REI can be calculated based on the basic principles of Popendorf (1985), as represented in the following equations of Ross and Dong (1996):

$$REI = [(\ln DFR_T) - (\ln DFR_0)] \times (k^{-1}) \quad [4]$$

where  $\ln DFR_T$  is the DFR level at the reentry interval T, which is associated with acceptable exposure with a 100-fold safety factor incorporated. Substituting,

$$REI = [\ln\{[(NOEL/100)(BW)]/[(TC)(mg/1,000 \mu g)(ED)]\} - (\ln DFR_0)] \times (k^{-1}) \quad [5]$$

where,

REI	=	the reentry interval (days)
NOEL/100	=	acceptable daily dose (mg/kg/day)
BW	=	worker's body weight (assumed to be 70 kg)
TC	=	transfer coefficient for a given crop and work activity (cm <sup>2</sup> /hr)
ED	=	hours worked per day (usually assumed to be 8 hrs/day)
Ln DFR <sub>0</sub>	=	natural logarithm of the DFR at time zero (μg/cm <sup>2</sup> )
k <sup>-1</sup>	=	the decay rate (slope) from plot of natural log-transformed DFR

Applying the above equation, REIs were calculated as follows, with the results shown in Tables 8 and 9:

$$REI = [\ln\{[(NOEL/100)(70 \text{ kg})]/[(TC)(mg/1,000 \mu g)(8 \text{ hr/day})]\} - (\ln DFR_0)] \times (k^{-1}) \quad [6]$$



**Table 8: Calculated Reentry Intervals (REIs) for Selected Work Activities Following Application of Endosulfan Emulsifiable Concentrate Formulations Using Default (USEPA) Versus Measured (ETF) Transfer Coefficients**

Crop Type	Work Activity	Dislodgeable Foliar Residue ( $\mu\text{g}/\text{cm}^2$ )				Reentry Interval (days) <sup>d</sup>	
		EPA		ETF		Log-linear model	Biphasic model
		DFR <sub>EPA</sub> <sup>a</sup>	DFR <sub>0</sub> <sup>b</sup>	DFR <sub>ETF</sub> <sup>c</sup>	DFR <sub>0</sub> <sup>b</sup>	REI <sup>e</sup> (EPA)	REI <sup>f</sup> (ETF)
Grapes	Harvesting	0.0175	0.188	0.147	0.55	24	3
	Irrigating	0.0656	0.188	1.53	0.55	11	1
Low Crops	Harvesting	0.105	0.944	0.832	0.87	18	1
	Scouting	0.263	0.944	1.49	0.87	10	1
Medium Crops	Harvesting	0.0656	0.944	0.184	0.87	22	4
High Crops	Harvesting	0.0263	0.944	0.125	0.87	29	5
	Scouting/Irrigating	0.0656	0.944	0.397	0.87	22	2
Fruit Trees	Harvesting	0.0263	0.147	0.324	0.30	19	1
Ornamentals	Irrigating	0.0656	0.147	8.85	0.30	9	1
Ornamentals	Packing	0.105	0.147	0.959	0.30	4	1

<sup>a</sup> DFR yielding MOE = 100 using the equation below and the EPA transfer coefficient (TC) values from Table 7:

$$\text{DFR} = [(\text{BW})(3 \text{ mg/kg/day})/100](1000 \mu\text{g/mg})/[(\text{TC})(8 \text{ hr/day})].$$

<sup>b</sup> DFR<sub>0</sub> is the antilog of the y intercept from a regression of ln DFR on time; the DFR<sub>0</sub> values estimated by the ETF are based on biphasic kinetics.

<sup>c</sup> DFR yielding MOE = 100 using the equation below and the ETF transfer coefficient (TC) values from Table 7:

$$\text{DFR} = [(\text{BW})(9 \text{ mg/kg/day})/100](1000 \mu\text{g/mg})/[(\text{TC})(8 \text{ hr/day})].$$

<sup>d</sup> If the calculated REI is less than 1 day or negative, the minimum REI value of 1 day (i.e., 24 hour) is assigned.

<sup>e</sup> REI (days) = (ln DFR<sub>EPA</sub> – ln DFR<sub>0</sub>)/(slope), based on a NOEL of 3 mg/kg/day; the EPA slopes for the EC formulation were - 0.10004 for grapes, - 0.12341 for melons (used for field crops), and - 0.09131 for peaches (used for fruit trees and ornamentals); although these slopes for the EC formulation were mentioned in the HED document (USEPA 2000a), the Agency did not provide calculations based on the EC formulation.

<sup>f</sup> REI (days) = (ln DFR<sub>ETF</sub> – ln DFR<sub>0</sub>)/(slope), based on a NOEL of 9 mg/kg/day. All of the curves resulting from a regression of ln (DFR) on time are biphasic, i.e, they have a rapid decay phase followed by a slower decay phase. The Phase 1 slopes for the EC formulation were - 0.41296 for grapes, - 0.42539 for melons (used for field crops) and - 0.30549 for peaches (used for fruit trees and ornamentals).

**Table 9: Calculated Reentry Intervals (REIs) for Selected Work Activities Following Application of Endosulfan Wettable Powder Formulations Using Default (EPA) Versus Measured (ETF) Transfer Coefficients**

Crop Type	Work Activity	Dislodgeable Foliar Residue ( $\mu\text{g}/\text{cm}^2$ )				Reentry Interval (days) <sup>d</sup>	
		EPA		ETF		Log-linear model	Biphasic model
		DFR <sub>EPA</sub> <sup>a</sup>	DFR <sub>0</sub> <sup>b</sup>	DFR <sub>ETF</sub> <sup>c</sup>	DFR <sub>0</sub> <sup>b</sup>	REI <sup>e</sup> (EPA)	REI <sup>f</sup> (ETF)
Grapes	Harvesting	0.0175	0.84	0.147	1.36	54	~30
	Irrigating	0.0656	0.84	1.53	1.36	36	1
Low Crops	Harvesting	0.105	2.11	0.832	1.12	22	1
	Scouting	0.263	2.11	1.49	1.12	15	1
Medium Crops	Harvesting	0.0656	2.11	0.184	1.12	25	8
High Crops	Harvesting	0.0263	2.11	0.125	1.12	31	9
	Scouting/Irrigating	0.0656	2.11	0.397	1.12	25	4
Fruit Trees	Harvesting	0.0263	0.57	0.324	0.78	32	5
Ornamentals	Irrigating	0.0656	0.573	8.85	0.78	22	1
Ornamentals	Packing	0.105	0.573	0.959	0.78	17	1

<sup>a</sup> DFR yielding MOE = 100 using the equation below and the EPA transfer coefficient (TC) values from Table 7:

$$\text{DFR} = [(\text{BW})(3 \text{ mg/kg/day})/100](1000 \mu\text{g/mg})/[(\text{TC})(8 \text{ hr/day})].$$

<sup>b</sup> DFR<sub>0</sub> is the antilog of the y intercept from a regression of ln DFR on time; the DFR<sub>0</sub> values estimated by the ETF are based on biphasic kinetics.

<sup>c</sup> DFR yielding MOE = 100 using the equation below and the ETF transfer coefficient (TC) values from Table 7:

$$\text{DFR} = [(\text{BW})(9 \text{ mg/kg/day})/100](1000 \mu\text{g/mg})/[(\text{TC})(8 \text{ hr/day})].$$

<sup>d</sup> If the calculated REI is less than 1 day or negative, the minimum REI value of 1 day (i.e., 24 hour) is assigned.

<sup>e</sup> REI (days) = (ln DFR<sub>EPA</sub> – ln DFR<sub>0</sub>)/(slope), based on a NOEL of 3 mg/kg/day; the EPA slopes for the WP formulation (USEPA 2000a) were - 0.07169 for grapes, - 0.13955 for melons (used for field crops), and - 0.09728 for peaches (used for fruit trees and ornamentals).

<sup>f</sup> REI (days) = (ln DFR<sub>ETF</sub> – ln DFR<sub>0</sub>)/(slope), based on a NOEL of 9 mg/kg/day. All of the curves resulting from a regression of ln (DFR) on time are biphasic, i.e, they have a rapid decay phase followed by a slower decay phase. The ETF Phase 1 slopes for the WP formulation were - 0.1969 for grapes, - 0.23744 for melons (used for field crops) and - 0.17093 for peaches (used for fruit trees and ornamentals); the Phase II slope for grapes was - 0.04924.

## VI. RESULTS

If the ARTF transfer coefficients are used in conjunction with (1) correctly interpreted formulation-specific and crop-specific DFR dissipation data; (2) crop-specific label rates; (3) the most appropriate NOEL of 9 mg/kg/day as proposed by the Task Force; and (4) a total uncertainty factor of 100, the REIs for each crop/site combination are significantly reduced compared to the estimates indicated in the HED document (USEPA 2000a). A summary of the results with respect to the calculated REI values (i.e., the number of days after application when the MOE is greater than or equal to 100), is shown in Table 10. The REIs that were directly derived were consistent with the separate daily exposure estimates based on predicted DFR levels from biphasic curve fitting. For the EC formulation, 24-hour REIs were calculated for irrigation of grapes, harvesting and scouting of crops with low potential for dermal transfer, harvesting in fruit trees, and irrigation and packing of ornamentals. Also for the EC formulation, REIs greater than 24 hours were derived for harvesting grapes (3 days), harvesting crops with medium potential for dermal transfer (4 days), harvesting crops with high potential for dermal transfer (5 days), and scouting and irrigating crops with high potential for dermal transfer (2 days). For the WP formulation, 24-hour REIs were calculated for irrigation of grapes, harvesting and scouting of crops with low potential for dermal transfer, and irrigation and packing of ornamentals. Also for the WP formulation, REIs greater than 24 hours were derived for harvesting grapes (~30 days), harvesting crops with medium potential for dermal transfer (8 days), harvesting crops with high potential for dermal transfer (9 days), scouting and irrigating crops with high potential for dermal transfer (4 days), and harvesting in fruit trees (5 days).

**Table 10. Summary of Calculated REIs Based on Biphasic Kinetics**

Crop	Work Activity	Transfer Coefficient (cm <sup>2</sup> /hr)	EC Formulation		WP Formulation	
			Use Rate (lbs a.i./acre)	REI (days)	Use Rate (lbs a.i./acre)	REI (days)
Grapes	Harvesting	5,350	1.5	3	1.5	~30
	Irrigating	514	1.5	1	1.5	1
Low Crops	Harvesting	946	1.0	1	1.0	1
	Scouting	528	1.0	1	1.0	1
Medium Crops	Harvesting	4,290	1.0	4	1.0	8
High Crops	Harvesting	6,309	1.0	5	1.0	9
	Scouting/Irrigating	1,983	1.0	2	1.0	4
Fruit Trees	Harvesting	2,431	3.0	1	3.0	5
Ornamentals	Irrigation	89	3.0	1	3.0	1
	Packing	821	3.0	1	3.0	1

## VII. DISCUSSION

In summary, we have proposed consideration of the biphasic kinetics of the DFR dissipation data in order to obtain a better predictive model for DFRs and for the resulting calculated REIs. In all cases the  $r^2$  value for Phase 1 (the critical time range for the great majority of the calculated DFRs) indicates a better fit to the data than a simple log-linear fit across the entire time frame of DFR dissipation. In approximately half of the cases, the  $r^2$  value for Phase 2 is less than 0.70, which indicates the fit for this second phase is less than ideal. However, because the calculated REIs occur within Phase 1 (except for grape harvesting for the WP formulation), this has no impact on the appropriateness of the REIs for the crop/work activity groupings when calculated using the predicted DFR values based on the Phase 1 regression equations. The REIs estimated in this report are likely to overestimate central tendency reentry intervals. For example, because some of the transfer coefficient (TC) values (e.g., for harvesting medium and high crops) represent the upper end of the range of the ARTF values, the REIs for these worker reentry activities may be artificially high. Furthermore, some of the TC values for a given worker reentry activity may be distributed in a lognormal fashion, in which case the geometric mean value would be a more appropriate measure of central tendency than the arithmetic mean which was used. Additional refinements in the REI estimates associated with these formulations may result in shorter allowable reentry intervals than indicated in this report.

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## **ATTACHMENT A**

### **Plots of Endosulfan DFR Dissipation Curves Under Various Kinetics Assumptions**

Figure A-1. Regression of Endosulfan Grape DFR on Time for EC Formulation

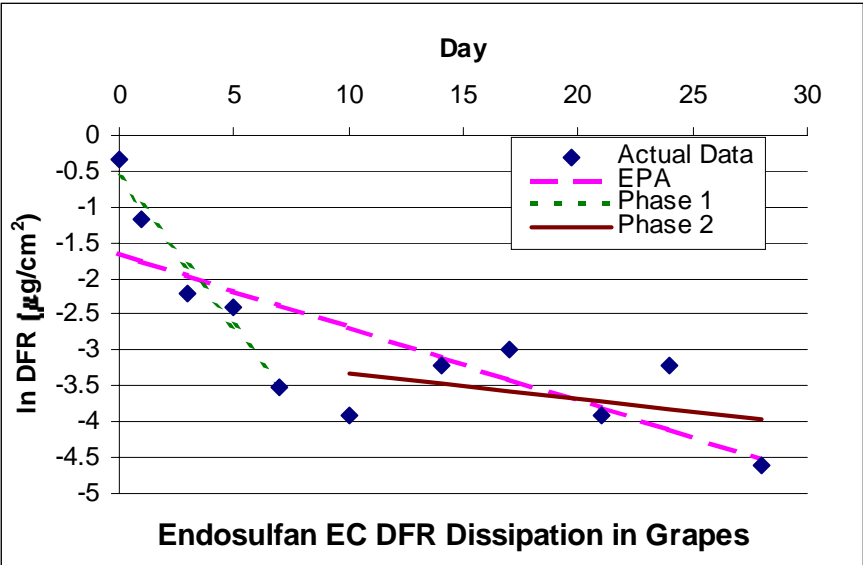


Figure A-2. Regression of Endosulfan Peach DFR on Time for EC Formulation

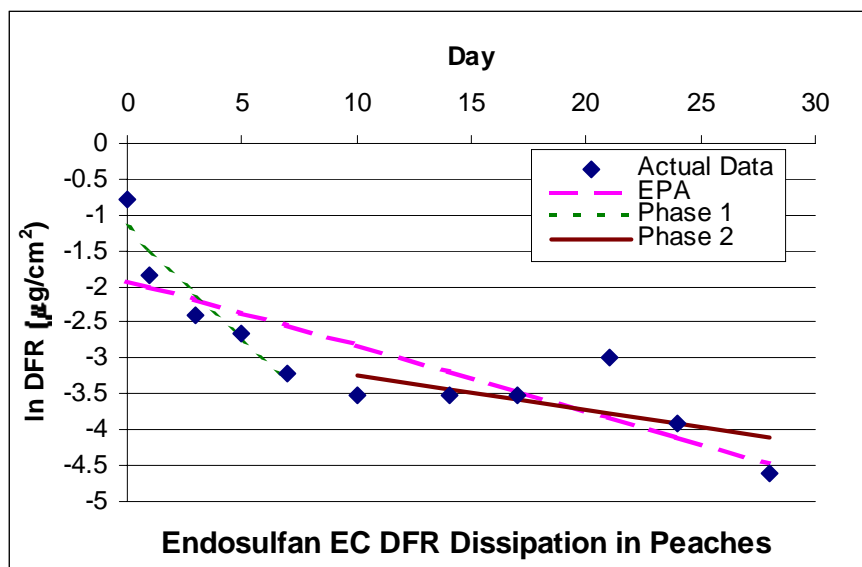


Figure A-3. Regression of Endosulfan Melon DFR on Time for EC Formulation

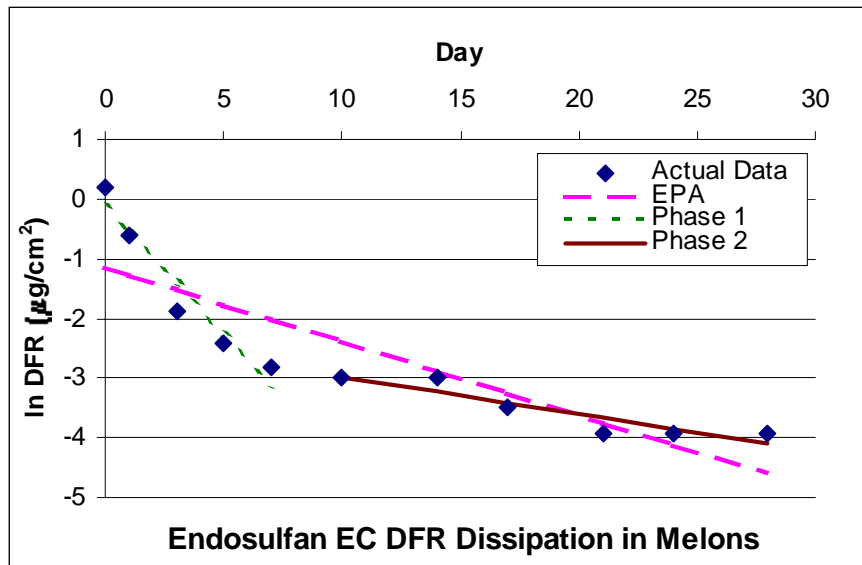


Figure A-4. Regression of Endosulfan Grape DFR on Time for WP Formulation

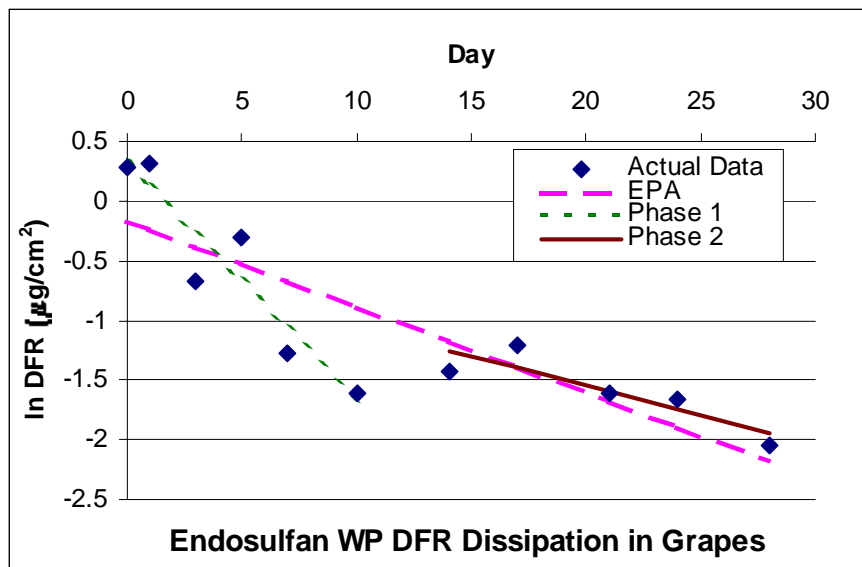


Figure A-5. Regression of Endosulfan Peach DFR on Time for WP Formulation

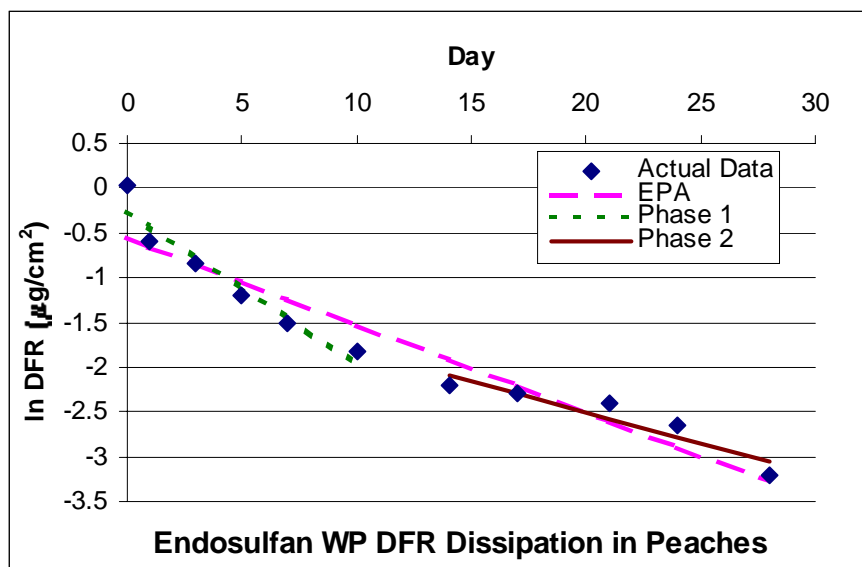
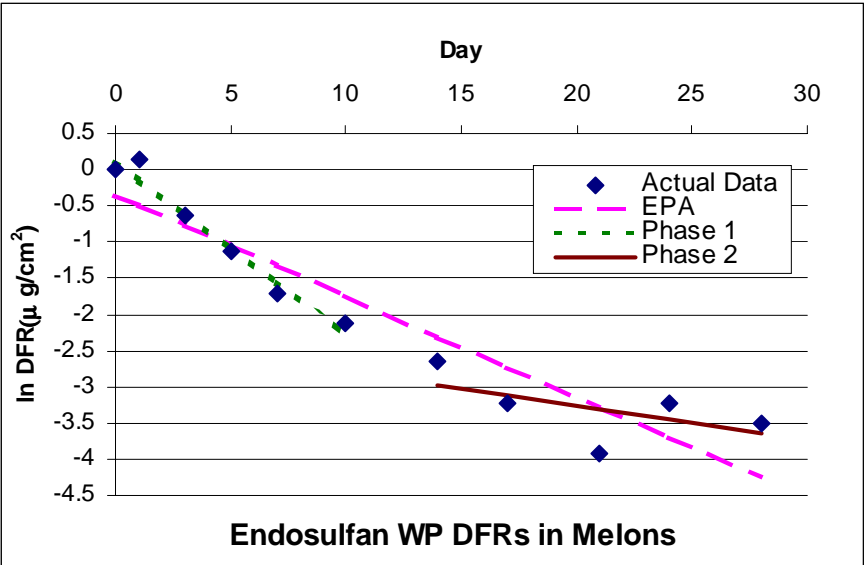


Figure A-6. Regression of Endosulfan Melon DFR on Time for WP Formulation



## **ATTACHMENT B**

### **Predicted Daily Reentry Exposures to Endosulfan For Various Work Activities and Crops**

**Table B-1. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan EC Use on Field Crops With Low Potential for Dermal Transfer**

For EC Formulation Applied at 1 lb a.i./acre to Crops With Low Potential for Dermal Transfer							
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 946 $\text{cm}^2/\text{hr}^c$		DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Scouting/Irrigating TC = 528 $\text{cm}^2/\text{hr}^d$	
		Dermal Dose <sup>e</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>f</sup>			Dermal Dose <sup>e</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>f</sup>
0	0.87	0.094	96	0	0.87	0.053	170
1	0.57	0.062	150	1	0.57	0.034	260
2	0.37	0.040	230	2	0.37	0.022	410
3	0.24	0.026	350	3	0.24	0.014	640
4	0.16	0.017	530	4	0.16	0.0097	930
5	0.10	0.011	820	5	0.10	0.0060	1,500
6	0.067	0.007	1,300	6	0.067	0.0040	2,300
7	0.044	0.0048	1,900	7	0.044	0.0027	3,300
8	0.057	0.0062	1,500	8	0.057	0.0034	2,600
9	0.054	0.0058	1,600	9	0.054	0.0033	2,700
10	0.051	0.0055	1,600	10	0.051	0.0031	2,900
11	0.048	0.0052	1,700	11	0.048	0.0029	3,100
12	0.045	0.0049	1,800	12	0.045	0.0027	3,300
13	0.042	0.0045	2,000	13	0.042	0.0025	3,600
14	0.040	0.0043	2,100	14	0.040	0.0024	3,800
15	0.037	0.0040	2,300	15	0.037	0.0022	4,100
16	0.035	0.0038	2,400	16	0.035	0.0021	4,300
17	0.033	0.0036	2,500	17	0.033	0.0020	4,500
18	0.031	0.0034	2,600	18	0.031	0.0019	4,700
19	0.029	0.0031	2,900	19	0.029	0.0018	5,000
20	0.027	0.0029	3,100	20	0.027	0.0016	5,600

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 1 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Representative of harvesting field crops with low dermal transfer potential such as broccoli, celery, collards.

<sup>d</sup> Representative of scouting/irrigating in crops such as broccoli, celery, collards, and early season scouting of cotton.

<sup>e</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) = [DFR ( $\mu\text{g}/\text{cm}^2$ ) x TC ( $\text{cm}^2/\text{hr}$ ) x (1  $\text{mg}/1,000 \mu\text{g}$ ) x ET ( $\text{hr}/\text{day}$ )]/BW ( $\text{kg}$ ).

<sup>f</sup> MOE = [NOEL ( $\text{mg}/\text{kg}/\text{day}$ )]/[Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ )], where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-2. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan EC Use on Field Crops With Medium Potential for Dermal Transfer**

For EC Formulation Applied at 1 lb a.i./acre to Crops With Medium Potential for Dermal Transfer			
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 4,290 $\text{cm}^2/\text{hr}^c$	
		Dermal Dose <sup>d</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>e</sup>
0	0.87	0.43	21
1	0.57	0.28	32
2	0.37	0.18	50
3	0.24	0.12	75
4	0.16	0.078	120
5	0.10	0.049	180
6	0.067	0.033	270
7	0.044	0.022	410
8	0.057	0.028	320
9	0.054	0.026	350
10	0.051	0.025	360
11	0.048	0.024	380
12	0.045	0.022	410
13	0.042	0.021	430
14	0.040	0.020	450
15	0.037	0.018	500
16	0.035	0.017	530
17	0.033	0.016	560
18	0.031	0.015	600
19	0.029	0.014	640
20	0.027	0.013	690

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 1 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Representative of harvesting field crops with medium dermal transfer potential (e.g., beans, cucumbers, eggplants, strawberries).

<sup>d</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) =  $[\text{DFR } (\mu\text{g}/\text{cm}^2) \times \text{TC } (\text{cm}^2/\text{hr}) \times (1 \text{ mg}/1,000 \mu\text{g}) \times \text{ET } (\text{hr}/\text{day})]/\text{BW } (\text{kg})$ .

<sup>e</sup> MOE =  $[\text{NOEL } (\text{mg}/\text{kg}/\text{day})]/[\text{Dermal Dose } (\text{mg}/\text{kg}/\text{day})]$ , where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-3. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan EC Use in Field Crops With High Potential for Dermal Transfer**

For EC Formulation Applied at 1 lb a.i./acre to Crops With High Potential for Dermal Transfer							
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 6,309 $\text{cm}^2/\text{hr}^c$		DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Scouting/Irrigating TC = 1,983 $\text{cm}^2/\text{hr}^d$	
		Dermal Dose <sup>e</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>f</sup>			Dermal Dose <sup>e</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>f</sup>
0	0.87	0.63	14	0	0.87	0.20	45
1	0.57	0.41	22	1	0.57	0.13	69
2	0.37	0.27	33	2	0.37	0.084	110
3	0.24	0.17	53	3	0.24	0.054	170
4	0.16	0.12	75	4	0.16	0.036	250
5	0.10	0.072	130	5	0.10	0.023	390
6	0.067	0.048	190	6	0.067	0.015	600
7	0.044	0.032	280	7	0.044	0.010	900
8	0.057	0.041	220	8	0.057	0.013	690
9	0.054	0.039	230	9	0.054	0.012	750
10	0.051	0.037	240	10	0.051	0.012	750
11	0.048	0.035	260	11	0.048	0.011	820
12	0.045	0.032	280	12	0.045	0.010	900
13	0.042	0.030	300	13	0.042	0.0095	950
14	0.040	0.029	310	14	0.040	0.0091	990
15	0.037	0.027	330	15	0.037	0.0084	1,100
16	0.035	0.025	360	16	0.035	0.0079	1,100
17	0.033	0.024	380	17	0.033	0.0075	1,200
18	0.031	0.022	410	18	0.031	0.0070	1,300
19	0.029	0.021	430	19	0.029	0.0066	1,400
20	0.027	0.019	470	20	0.027	0.0061	1,500

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 1 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Representative of harvesting field crops with high dermal transfer potential such as corn, tomatoes, and tubers.

<sup>d</sup> Representative of scouting/irrigating in crops such as corn and tomatoes.

<sup>e</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) =  $[\text{DFR } (\mu\text{g}/\text{cm}^2) \times \text{TC } (\text{cm}^2/\text{hr}) \times (1 \text{ mg}/1,000 \mu\text{g}) \times \text{ET } (\text{hr}/\text{day})]/\text{BW } (\text{kg})$ .

<sup>f</sup> MOE =  $[\text{NOEL } (\text{mg}/\text{kg}/\text{day})]/[\text{Dermal Dose } (\text{mg}/\text{kg}/\text{day})]$ , where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-4. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan EC Use in Grapes: Harvesting**

For EC Formulation Applied at 1.5 lb a.i./acre to Grapes							
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 5,350 $\text{cm}^2/\text{hr}$		DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 5,350 $\text{cm}^2/\text{hr}$	
		Dermal Dose <sup>c</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>d</sup>			Dermal Dose <sup>c</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>d</sup>
0	0.55	0.34	26	21	0.024	0.015	600
1	0.36	0.22	41	22	0.023	0.014	640
2	0.24	0.15	60	23	0.023	0.014	640
3	0.16	0.098	92	24	0.022	0.013	690
4	0.10	0.061	150	25	0.021	0.013	690
5	0.069	0.042	210	26	0.020	0.012	750
6	0.046	0.028	320	27	0.019	0.012	750
7	0.030	0.018	500	28	0.019	0.012	750
8	0.039	0.024	380	29	0.018	0.011	820
9	0.038	0.023	390	30	0.017	0.010	900
10	0.036	0.022	410	31	0.017	0.010	900
11	0.035	0.021	430	32	0.016	0.0098	920
12	0.034	0.021	430	33	0.016	0.0098	920
13	0.033	0.020	450	34	0.015	0.0092	980
14	0.031	0.019	470	35	0.015	0.0092	980
15	0.030	0.018	500	36	0.014	0.0086	1,000
16	0.029	0.018	500	37	0.014	0.0086	1,000
17	0.028	0.017	530	38	0.013	0.0079	1,100
18	0.027	0.017	530	39	0.013	0.0079	1,100
19	0.026	0.016	560	40	0.012	0.0073	1,200
20	0.025	0.015	600	41	0.012	0.0073	1,200

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 1.5 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) = [DFR ( $\mu\text{g}/\text{cm}^2$ ) x TC ( $\text{cm}^2/\text{hr}$ ) x (1  $\text{mg}/1,000 \mu\text{g}$ ) x ET ( $\text{hr}/\text{day}$ )]/BW ( $\text{kg}$ ).

<sup>d</sup> MOE = [NOEL ( $\text{mg}/\text{kg}/\text{day}$ )]/[Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ )], where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-5. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan EC Use in Grapes: Irrigation**

For EC Formulation Applied at 1.5 lb a.i./acre to Grapes							
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Irrigating TC = 514 $\text{cm}^2/\text{hr}$		DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Irrigating TC = 514 $\text{cm}^2/\text{hr}$	
		Dermal Dose <sup>c</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>d</sup>			Dermal Dose <sup>c</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>d</sup>
0	0.55	0.032	280	21	0.024	0.0014	6,400
1	0.36	0.021	430	22	0.023	0.0014	6,400
2	0.24	0.014	640	23	0.023	0.0014	6,400
3	0.16	0.0094	960	24	0.022	0.0013	6,900
4	0.10	0.0059	1,500	25	0.021	0.0012	7,500
5	0.069	0.0041	2,200	26	0.020	0.0012	7,500
6	0.046	0.0027	3,300	27	0.019	0.0011	8,200
7	0.030	0.0018	5,000	28	0.019	0.0011	8,200
8	0.039	0.0023	3,900	29	0.018	0.0011	8,200
9	0.038	0.0022	4,100	30	0.017	0.0010	9,000
10	0.036	0.0021	4,300	31	0.017	0.0010	9,000
11	0.035	0.0021	4,300	32	0.016	0.00094	9,600
12	0.034	0.0020	4,500	33	0.016	0.00094	9,600
13	0.033	0.0019	4,700	34	0.015	0.00088	10,000
14	0.031	0.0018	5,000	35	0.015	0.00088	10,000
15	0.030	0.0018	5,000	36	0.014	0.00082	11,000
16	0.029	0.0017	5,300	37	0.014	0.00082	11,000
17	0.028	0.0016	5,600	38	0.013	0.00076	12,000
18	0.027	0.0016	5,600	39	0.013	0.00076	12,000
19	0.026	0.0015	6,000	40	0.012	0.00071	13,000
20	0.025	0.0015	6,000	41	0.012	0.00071	13,000

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 1.5 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) = [DFR ( $\mu\text{g}/\text{cm}^2$ ) x TC ( $\text{cm}^2/\text{hr}$ ) x (1  $\text{mg}/1,000 \mu\text{g}$ ) x ET ( $\text{hr}/\text{day}$ )]/BW (kg).

<sup>d</sup> MOE = [NOEL ( $\text{mg}/\text{kg}/\text{day}$ )]/[Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ )], where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-6. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan EC Use on Fruit Trees: Harvesting**

For EC Formulation Applied at 3 lb a.i./acre to Fruit Trees			
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 2,431 $\text{cm}^2/\text{hr}$ <sup>c</sup>	
		Dermal Dose <sup>d</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>e</sup>
0	0.30	0.083	110
1	0.22	0.061	150
2	0.16	0.044	200
3	0.12	0.033	270
4	0.089	0.025	360
5	0.065	0.018	500
6	0.048	0.013	690
7	0.035	0.0097	930
8	0.044	0.012	750
9	0.042	0.012	750
10	0.040	0.011	820
11	0.038	0.011	820
12	0.036	0.010	900
13	0.034	0.0094	960
14	0.033	0.0092	980
15	0.031	0.0086	1,000
16	0.029	0.0081	1,100
17	0.028	0.0078	1,200
18	0.027	0.0075	1,200
19	0.025	0.0069	1,300
20	0.024	0.0067	1,300

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 3.0 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Representative of harvesting and pruning of fruit trees.

<sup>d</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) = [DFR ( $\mu\text{g}/\text{cm}^2$ ) x TC ( $\text{cm}^2/\text{hr}$ ) x (1  $\text{mg}/1,000 \mu\text{g}$ ) x ET ( $\text{hr}/\text{day}$ )]/BW (kg).

<sup>e</sup> MOE = [NOEL ( $\text{mg}/\text{kg}/\text{day}$ )]/[Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ )], where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-7. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan EC Use on Ornamentals**

For EC Formulation Applied at 3.0 lb a.i./acre to Ornamentals							
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Irrigating TC = 89 cm <sup>2</sup> /hr <sup>c</sup>		DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Packing TC = 821 cm <sup>2</sup> /hr <sup>d</sup>	
		Dermal Dose <sup>e</sup> (mg/kg/day)	MOE <sup>f</sup>			Dermal Dose <sup>e</sup> (mg/kg/day)	MOE <sup>f</sup>
0	0.30	0.0031	2,900	0	0.30	0.028	320
1	0.22	0.0022	4,100	1	0.22	0.021	430
2	0.16	0.0016	5,600	2	0.16	0.015	600
3	0.12	0.0012	7,500	3	0.12	0.011	820
4	0.089	0.00091	9,900	4	0.089	0.0084	1,100
5	0.065	0.00066	14,000	5	0.065	0.0061	1,500
6	0.048	0.00049	18,000	6	0.048	0.0045	2,000
7	0.035	0.00036	25,000	7	0.035	0.0033	2,700
8	0.044	0.00045	20,000	8	0.044	0.0041	2,200
9	0.042	0.00043	21,000	9	0.042	0.0039	2,300
10	0.040	0.00041	22,000	10	0.040	0.0038	2,400
11	0.038	0.00039	23,000	11	0.038	0.0036	2,500
12	0.036	0.00037	24,000	12	0.036	0.0034	2,600
13	0.034	0.00035	26,000	13	0.034	0.0032	2,800
14	0.033	0.00034	26,000	14	0.033	0.0031	2,900
15	0.031	0.00032	28,000	15	0.031	0.0029	3,100
16	0.029	0.00030	30,000	16	0.029	0.0027	3,300
17	0.028	0.00029	31,000	17	0.028	0.0026	3,500
18	0.027	0.00028	32,000	18	0.027	0.0025	3,600
19	0.025	0.00025	36,000	19	0.025	0.0023	3,900
20	0.024	0.00024	38,000	20	0.024	0.0023	3,900

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 3.0 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Assumed to be representative of irrigating outdoor ornamentals.

<sup>d</sup> Assumed to be representative of sorting/packing outdoor ornamentals.

<sup>e</sup> Dermal Dose (mg/kg/day) = [DFR ( $\mu\text{g}/\text{cm}^2$ ) x TC (cm<sup>2</sup>/hr) x (1 mg/1,000  $\mu\text{g}$ ) x ET (hr/day)]/BW (kg).

<sup>f</sup> MOE = [NOEL (mg/kg/day)]/[Dermal Dose (mg/kg/day)], where NOEL = 9 mg/kg/day.

**Table B-8. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan WP Use on Field Crops With Low Potential for Dermal Transfer**

For WP Formulation Applied at 1 lb a.i./acre to Crops With Low Potential for Dermal Transfer							
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 946 $\text{cm}^2/\text{hr}^c$		DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Scouting/Irrigating TC = 528 $\text{cm}^2/\text{hr}^d$	
		Dermal Dose <sup>e</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>f</sup>			Dermal Dose <sup>e</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>f</sup>
0	1.12	0.12	75	0	1.12	0.068	130
1	0.89	0.096	94	1	0.89	0.054	170
2	0.70	0.076	120	2	0.70	0.042	210
3	0.55	0.059	150	3	0.55	0.033	270
4	0.43	0.046	200	4	0.43	0.026	350
5	0.34	0.037	240	5	0.34	0.021	430
6	0.27	0.029	310	6	0.27	0.016	560
7	0.21	0.023	390	7	0.21	0.013	690
8	0.17	0.018	500	8	0.17	0.010	900
9	0.13	0.014	640	9	0.13	0.0078	1,200
10	0.10	0.011	820	10	0.10	0.0060	1,500
11	0.059	0.0064	1,400	11	0.059	0.0036	2,500
12	0.057	0.0062	1,500	12	0.057	0.0034	2,600
13	0.054	0.0058	1,600	13	0.054	0.0033	2,700
14	0.051	0.0055	1,600	14	0.051	0.0031	2,900
15	0.049	0.0053	1,700	15	0.049	0.0030	3,000
16	0.047	0.0051	1,800	16	0.047	0.0028	3,200
17	0.044	0.0048	1,900	17	0.044	0.0027	3,300
18	0.042	0.0045	2,000	18	0.042	0.0025	3,600
19	0.040	0.0043	2,100	19	0.040	0.0024	3,800
20	0.038	0.0041	2,200	20	0.038	0.0023	3,900

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 1 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Representative of harvesting field crops with low dermal transfer potential such as broccoli, celery, collards.

<sup>d</sup> Representative of scouting/irrigating in crops such as broccoli, celery, collards, and early season scouting of cotton.

<sup>e</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) =  $[\text{DFR } (\mu\text{g}/\text{cm}^2) \times \text{TC } (\text{cm}^2/\text{hr}) \times (1 \text{ mg}/1,000 \mu\text{g}) \times \text{ET } (\text{hr}/\text{day})]/\text{BW } (\text{kg})$ .

<sup>f</sup> MOE =  $[\text{NOEL } (\text{mg}/\text{kg}/\text{day})]/[\text{Dermal Dose } (\text{mg}/\text{kg}/\text{day})]$ , where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-9. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan WP Use on Field Crops With Medium Potential for Dermal Transfer**

For WP Formulation Applied at 1 lb a.i./acre to Crops With Medium Potential for Dermal Transfer			
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 4,290 $\text{cm}^2/\text{hr}^c$	
		Dermal Dose <sup>d</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>e</sup>
0	1.12	0.55	16
1	0.89	0.44	20
2	0.70	0.34	26
3	0.55	0.27	33
4	0.43	0.21	43
5	0.34	0.17	53
6	0.27	0.13	69
7	0.21	0.10	90
8	0.17	0.083	110
9	0.13	0.064	140
10	0.10	0.049	180
11	0.059	0.029	310
12	0.057	0.028	320
13	0.054	0.026	350
14	0.051	0.025	360
15	0.049	0.024	380
16	0.047	0.023	390
17	0.044	0.022	410
18	0.042	0.021	430
19	0.040	0.020	450
20	0.038	0.019	470

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 1 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Representative of harvesting field crops with medium dermal transfer potential (e.g., beans, cucumbers, eggplants, strawberries).

<sup>d</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) = [DFR ( $\mu\text{g}/\text{cm}^2$ ) x TC ( $\text{cm}^2/\text{hr}$ ) x (1  $\text{mg}/1,000 \mu\text{g}$ ) x ET ( $\text{hr}/\text{day}$ )]/BW (kg).

<sup>e</sup> MOE = [NOEL ( $\text{mg}/\text{kg}/\text{day}$ )]/[Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ )], where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-10. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan WP Use in Field Crops With High Potential for Dermal Transfer**

For WP Formulation Applied at 1 lb a.i./acre to Crops With High Potential for Dermal Transfer							
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 6,309 $\text{cm}^2/\text{hr}^c$		DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Scouting/Irrigating TC = 1,983 $\text{cm}^2/\text{hr}^d$	
		Dermal Dose <sup>e</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>f</sup>			Dermal Dose <sup>e</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>f</sup>
0	1.12	0.81	11	0	1.12	0.25	36
1	0.89	0.64	14	1	0.89	0.20	45
2	0.70	0.50	18	2	0.70	0.16	56
3	0.55	0.40	23	3	0.55	0.12	75
4	0.43	0.31	29	4	0.43	0.097	93
5	0.34	0.25	36	5	0.34	0.077	120
6	0.27	0.19	47	6	0.27	0.061	150
7	0.21	0.15	60	7	0.21	0.048	190
8	0.17	0.12	75	8	0.17	0.039	230
9	0.13	0.094	96	9	0.13	0.029	310
10	0.10	0.072	130	10	0.10	0.023	390
11	0.059	0.043	210	11	0.059	0.013	690
12	0.057	0.041	220	12	0.057	0.013	690
13	0.054	0.039	230	13	0.054	0.012	750
14	0.051	0.037	240	14	0.051	0.012	750
15	0.049	0.035	260	15	0.049	0.011	820
16	0.047	0.034	260	16	0.047	0.011	820
17	0.044	0.032	280	17	0.044	0.010	900
18	0.042	0.030	300	18	0.042	0.0095	950
19	0.040	0.029	310	19	0.040	0.0091	990
20	0.038	0.027	330	20	0.038	0.0086	1,000

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 1 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Representative of harvesting field crops with high dermal transfer potential such as corn, tomatoes, and tubers.

<sup>d</sup> Representative of scouting/irrigating in crops such as corn and tomatoes.

<sup>e</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) =  $[\text{DFR } (\mu\text{g}/\text{cm}^2) \times \text{TC } (\text{cm}^2/\text{hr}) \times (1 \text{ mg}/1,000 \mu\text{g}) \times \text{ET } (\text{hr}/\text{day})]/\text{BW } (\text{kg})$ .

<sup>f</sup> MOE =  $[\text{NOEL } (\text{mg}/\text{kg}/\text{day})]/[\text{Dermal Dose } (\text{mg}/\text{kg}/\text{day})]$ , where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-11. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan WP Use in Grapes: Harvesting**

For WP Formulation Applied at 1.5 lb a.i./acre to Grapes							
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 5,350 $\text{cm}^2/\text{hr}$		DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 5,350 $\text{cm}^2/\text{hr}$	
		Dermal Dose <sup>c</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>d</sup>			Dermal Dose <sup>c</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>d</sup>
0	1.36	0.83	11	21	0.20	0.12	75
1	1.12	0.68	13	22	0.19	0.12	75
2	0.92	0.56	16	23	0.18	0.11	82
3	0.75	0.46	20	24	0.17	0.10	90
4	0.62	0.38	24	25	0.17	0.10	90
5	0.51	0.31	29	26	0.16	0.098	92
6	0.42	0.26	35	27	0.15	0.092	98
7	0.34	0.21	43	28	0.14	0.086	100
8	0.28	0.17	53	29	0.14	0.086	100
9	0.23	0.14	64	30	0.13	0.079	110
10	0.19	0.12	75	31	0.12	0.073	120
11	0.33	0.20	45	32	0.12	0.073	120
12	0.32	0.20	45	33	0.11	0.067	130
13	0.30	0.18	50	34	0.11	0.067	130
14	0.29	0.18	50	35	0.10	0.061	150
15	0.27	0.17	53	36	0.097	0.059	150
16	0.26	0.16	56	37	0.092	0.056	160
17	0.25	0.15	60	38	0.088	0.054	170
18	0.23	0.14	64	39	0.083	0.051	180
19	0.22	0.13	69	40	0.079	0.048	190
20	0.21	0.13	69	41	0.076	0.046	200

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 1.5 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) = [DFR ( $\mu\text{g}/\text{cm}^2$ ) x TC ( $\text{cm}^2/\text{hr}$ ) x (1  $\text{mg}/1,000 \mu\text{g}$ ) x ET ( $\text{hr}/\text{day}$ )]/BW (kg).

<sup>d</sup> MOE = [NOEL ( $\text{mg}/\text{kg}/\text{day}$ )]/[Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ )], where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-12. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan WP Use in Grapes: Irrigation**

For WP Formulation Applied at 1.5 lb a.i./acre to Grapes							
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Irrigating TC = 514 $\text{cm}^2/\text{hr}$		DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Irrigating TC = 514 $\text{cm}^2/\text{hr}$	
		Dermal Dose <sup>c</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>d</sup>			Dermal Dose <sup>c</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>d</sup>
0	1.36	0.080	110	21	0.20	0.012	750
1	1.12	0.066	140	22	0.19	0.011	820
2	0.92	0.054	170	23	0.18	0.011	820
3	0.75	0.044	200	24	0.17	0.010	900
4	0.62	0.036	250	25	0.17	0.010	900
5	0.51	0.030	300	26	0.16	0.0094	960
6	0.42	0.025	360	27	0.15	0.0088	1,000
7	0.34	0.020	450	28	0.14	0.0082	1,100
8	0.28	0.016	560	29	0.14	0.0082	1,100
9	0.23	0.014	640	30	0.13	0.0076	1,200
10	0.19	0.011	820	31	0.12	0.0070	1,300
11	0.33	0.019	470	32	0.12	0.0070	1,300
12	0.32	0.019	470	33	0.11	0.0065	1,400
13	0.30	0.018	500	34	0.11	0.0065	1,400
14	0.29	0.017	530	35	0.10	0.0059	1,500
15	0.27	0.016	560	36	0.097	0.0057	1,600
16	0.26	0.015	600	37	0.092	0.0054	1,700
17	0.25	0.015	600	38	0.088	0.0052	1,700
18	0.23	0.014	640	39	0.083	0.0049	1,800
19	0.22	0.013	690	40	0.079	0.0046	2,000
20	0.21	0.012	750	41	0.076	0.0045	2,000

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 1.5 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) = [DFR ( $\mu\text{g}/\text{cm}^2$ ) x TC ( $\text{cm}^2/\text{hr}$ ) x (1  $\text{mg}/1,000 \mu\text{g}$ ) x ET ( $\text{hr}/\text{day}$ )]/BW ( $\text{kg}$ ).

<sup>d</sup> MOE = [NOEL ( $\text{mg}/\text{kg}/\text{day}$ )]/[Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ )], where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-13. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan WP Use on Fruit Trees: Harvesting**

For WP Formulation Applied at 3 lb a.i./acre to Fruit Trees			
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Harvesting TC = 2,431 $\text{cm}^2/\text{hr}$ <sup>c</sup>	
		Dermal Dose <sup>d</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>e</sup>
0	0.78	0.22	41
1	0.65	0.18	50
2	0.55	0.15	60
3	0.46	0.13	69
4	0.39	0.11	82
5	0.33	0.092	98
6	0.28	0.078	120
7	0.23	0.064	140
8	0.20	0.056	160
9	0.17	0.047	190
10	0.14	0.039	230
11	0.15	0.042	210
12	0.14	0.039	230
13	0.13	0.036	250
14	0.12	0.033	270
15	0.12	0.033	270
16	0.11	0.031	290
17	0.10	0.028	320
18	0.094	0.026	350
19	0.088	0.024	380
20	0.082	0.023	390

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 3.0 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Representative of harvesting and pruning of fruit trees.

<sup>d</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) = [DFR ( $\mu\text{g}/\text{cm}^2$ ) x TC ( $\text{cm}^2/\text{hr}$ ) x (1  $\text{mg}/1,000 \mu\text{g}$ ) x ET ( $\text{hr}/\text{day}$ )]/BW (kg).

<sup>e</sup> MOE = [NOEL ( $\text{mg}/\text{kg}/\text{day}$ )]/[Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ )], where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .

**Table B-14. Short-Term and Intermediate-Term Post-Application Occupational Assessment for Endosulfan WP Use on Ornamentals**

For WP Formulation Applied at 3.0 lb a.i./acre to Ornamentals							
DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Irrigating TC = 89 $\text{cm}^2/\text{hr}^c$		DAT <sup>a</sup>	DFR <sup>b</sup> ( $\mu\text{g}/\text{cm}^2$ )	Packing TC = 821 $\text{cm}^2/\text{hr}^d$	
		Dermal Dose <sup>e</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>f</sup>			Dermal Dose <sup>e</sup> ( $\text{mg}/\text{kg}/\text{day}$ )	MOE <sup>f</sup>
0	0.78	0.0079	1,100	0	0.78	0.073	120
1	0.65	0.0066	1,400	1	0.65	0.061	150
2	0.55	0.0056	1,600	2	0.55	0.052	170
3	0.46	0.0047	1,900	3	0.46	0.043	210
4	0.39	0.0040	2,300	4	0.39	0.037	240
5	0.33	0.0034	2,600	5	0.33	0.031	290
6	0.28	0.0028	3,200	6	0.28	0.026	350
7	0.23	0.0023	3,900	7	0.23	0.022	410
8	0.20	0.0020	4,500	8	0.20	0.019	470
9	0.17	0.0017	5,300	9	0.17	0.016	560
10	0.14	0.0014	6,400	10	0.14	0.013	690
11	0.15	0.0015	6,000	11	0.15	0.014	640
12	0.14	0.0014	6,400	12	0.14	0.013	690
13	0.13	0.0013	6,900	13	0.13	0.012	750
14	0.12	0.0012	7,500	14	0.12	0.011	820
15	0.12	0.0012	7,500	15	0.12	0.011	820
16	0.11	0.0011	8,100	16	0.11	0.010	900
17	0.10	0.0010	9,000	17	0.10	0.0094	960
18	0.094	0.00096	9,400	18	0.094	0.0088	1,000
19	0.088	0.00090	10,000	19	0.088	0.0083	1,100
20	0.082	0.00083	11,000	20	0.082	0.0077	1,200

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> Based on biphasic regression analysis of data from DFR study conducted at 3.0 lb a.i./acre (MRID No. 444031-02).

<sup>c</sup> Assumed to be representative of irrigating outdoor ornamentals.

<sup>d</sup> Assumed to be representative of sorting/packing outdoor ornamentals.

<sup>e</sup> Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ ) = [DFR ( $\mu\text{g}/\text{cm}^2$ ) x TC ( $\text{cm}^2/\text{hr}$ ) x (1  $\text{mg}/1,000 \mu\text{g}$ ) x ET ( $\text{hr}/\text{day}$ )]/BW ( $\text{kg}$ ).

<sup>f</sup> MOE = [NOEL ( $\text{mg}/\text{kg}/\text{day}$ )]/[Dermal Dose ( $\text{mg}/\text{kg}/\text{day}$ )], where NOEL = 9  $\text{mg}/\text{kg}/\text{day}$ .